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JUNE 24-27-2012

Obituary
Dr. Roland Corey Anderson (1946 - 2014)

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It was a shock for club members when they learned that Dr. Roland Anderson had passed away on February 19th. Roland was retired from the Seattle Aquarium, where he worked for 32 years as a biologist and researcher. His interest, and main field of study, was with cephalopods (octopuses and squids). His study of behavior of Pacific octopus, that he had done for 35 years, was world renowned. Roland gave several talks to the club, and was a frequent contributor to the Dredgings with articles and items. He left a lasting legacy through books and papers he authored and co-authored. Ever a gentle person, he was easy to talk to, and his presence at clubs meetings will be missed. G.H.

Roland Anderson - Some Recollections

Ronald L. Shimek

I first met Roland over the phone in 1985. I was working at what was then the Bamfield Marine Station and he contacted me with some questions about the aquarium husbandry of *Antalis pretiosum* as part of a Native American cultural exhibit at the Seattle Aquarium. Our interests meshed from the beginning with a continuing collaboration based around our mutual diving and aquarium observations of, at first, *Rossia*, and then octopuses, and sea stars. Finally, we had the most wonderful of collaborations where we found ourselves going from each other's experiences in different areas where we were each able to fill in the blanks in the other's narrative to build a coherent groundwork. This has resulted in several publications where we were able to publish information that would have otherwise languished. These articles ranged from observations about *Rossia* egg deposition, to escape responses in some funky sea stars, to bona fide attacks of the Giant Pacific Octopus on divers, to the Giant Pacific Octopus capturing and eating birds.

Roland was a superb diving biologist. Like all good research divers, at times he could spend a whole night dive examining a field of old beer bottles located off of a Seattle marina looking for small *Octopus rubescens*, which lived in those bottles. I have often wondered what someone walking by on the shoreline sidewalk would think of the flashes of my strobes going off in the bay on a rainy winter night. Then, of course, the answer is nobody saw the flashes of light because we two divers were the only ones insane enough to be diving offshore of a marina at night in the rain. But we got some good observations about these little octopuses and some other things such as large swimming nemertean worms.

It takes people like Roland, who are willing... Nay...who are ENTHUSIASTICALLY DRIVEN to go out in places like that marina's embayment to find out about the animals there; to want to find information about these small animals, and to tell their story. With his passing the world of Seattle's scientists gets significantly smaller. Roland was one of a special breed. He investigated animals that lived in places that few other people would venture into. Without people like Roland, we lose a very special window on the world.

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ABSTRACTS AND PAPERS FROM THE 45TH WESTERN SOCIETY OF MALACOLOGISTS MEETING

Contents

ABSTRACTS

PHYLOGEOGRAPHY OF THE GASTROPOD *BULLA OCCIDENTALIS* IN THE TROPICAL WESTERN ATLANTIC OCEAN

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The biogeography of the Neotropics is complex and several examples of genetic breaks within species have been illustrated for several groups of organisms (e.g. echinoderms, fish, mollusks). Such divergence is often attributed to oceanographic factors, transient allopatry and ecological factors, but no common biogeographical pattern has been found and mechanisms behind diversification within the region are not fully understood. Previous studies on the worldwide genus *Bulla* revealed deep genetic breaks in the species *Bulla occidentalis* along the tropical western Atlantic (Malaquias & Reid, 2009. J. Biogeography, 36: 1760). Here we expand the dataset used by Malaquias & Reid (2009) from 20 to 98 specimens with a nearly complete coverage of the geographical distribution of the species. We use two mitochondrial genes (COI and 16S rRNA) and analyse the datasets with population genetics, demographic, and phylogenetic methods incorporating molecular clocks and fossil data to reconstruct the phylogeographic history of *B. occidentalis*.

Bulla occidentalis showed a structured genealogy with three lineages with an average genetic distance of 4.6% – 5.9% (A: all coastline samples from Brazil to Eastern Florida, including Yucatan and the islands of Guadeloupe and Bermuda; B: all samples from the Florida Keys; C: mostly Cuban samples). Divergence between lineages was dated to the late Miocene (11.06 – 6.11 Mya) and may have been caused during transient allopatry caused by vicariant effects related to the Panamanian Isthmus uplift. However, the mechanisms maintaining divergence of these lineages are difficult to pinpoint because no direct link was established between the geographical subdivision and present oceanographic patterns, ecological factors or isolation-by-distance. Demographic history reconstruction showed an increase in genetic diversity and population size during the Pleistocene, coinciding with an increase in the magnitude of glaciation cycles that may have caused periods of transient allopatry likely reducing population connectivity leading to genetic diversification, as well as potentially creating new niche-opportunities during low sea-level stands allowing populations to expand.

POPULATION ECOLOGY OF *CUTHONA NANA* ALDER & HANCOCK, 1842 (GASTROPODA; NUDIBRANCHIA; AEOLIDINA) AT RÍA DE FERROL (GALICIA, NW IBERIAN PENINSULA): PRELIMINARY RESULTS

M. Abad[1], V. Urgorri[1], G. Díaz-Agras[1], J. Moreira[2], A. García-Regueira[1], R. Tato[1], M. Candás[1], Y. Lucas[1] and X. Cunha[1]

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The hermit crab *Pagurus bernhardus* Linnaeus, 1758 has a symbiotic relationship with the hydroid *Hydractinia echinata* Fleming, 1828, among whose polyps the aeolid opistobranch *Cuthona nana* Alder & Hancock, 1842 (Gastropoda, Nudibranchia, Aeolidina) lives. The opisthobranch camouflages almost perfectly among the hydroid polyps, as its color is very similar to that of the polyps and the shape of its cerata imitates the hydroid tentacles on which it feeds.

The methodology used in the study consists of a monthly collection of samples of *P. bernhardus* with *Hydractinia echinata* by scuba diving along each established infralittoral transect for 20 minutes. Samples are taken to the laboratory, where each hydroid colony is examined under binocular magnifying glass in order to locate the nudibranch. The number of specimens of *C. nana* in each shell, their size, spawns and copulating specimens are registered. Next, hermit crabs are released on the same bottom they were collected with the aim of minimizing the sampling effects on the abundance and therefore on the population dynamics of *C. nana*. Apart from these population samplings, some specimens of the nudibranch were collected in different areas and fixed in Bouin's fluid and ethanol 96% for subsequent anatomical and phylogenetic studies, respectively.

In this paper, the preliminary results of the study carried out at the Estación de Bioloxía Mariña da Graña (USC) on the population ecology of *C. nana* at Ría de Ferrol (Galicia, NW Iberian Peninsula) are presented. After a whole sampling year, preliminary results indicate the presence of specimens of the nudibranch *C. nana* throughout the year and show that the percentage of colonies of *H. echinata* with one or more specimens of *C. nana* reaches its peak during June and April (33.5% and 31.14%, respectively) and its lowest point in July (2.8%) an January (2.1%).

COMMUNITY STRUCTURE OF GASTROPODS FROM ISLA VERDE, VERACRUZ, MÉXICO

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Coral reefs are the habitat and serve as a refuge of different species of mollusks. In México there are several studies of gastropods, mainly on ecology, taxonomy and systematic. Despite this, our understanding of gastropods is not sufficient. This work aims to determine the community structure of gastropods in different seasons in Isla Verde, a reef of the Marine Park "Parque Nacional Sistema Arrecifal Veracruzano." Four campaigns were made in the marine

park using snorkeling and random sampling in the windy (October 2009-December 2010), dry (April 2010) and rainy (August 2010) seasons, covering a total area of 105 m^2 within the reef lagoon, using a 1 m^2 circle as sampling unit. Some environmental variables such as depth, temperature, salinity and *pH*, as well as associations between gastropods and other animals were recorded. A total of 1,086 organims included in 48 species, 22 families, and 31 genera were identified. From those, 15 are new records for the area. The most abundant species were *Cerithium litteratum*, *Lithopoma tectum* and *Modulus modulus*. Almost half of the organisms were found at the areas SE, SW, N, and in the middle of the reef lagoon. The Simpson index was 0.27, Shannon-Wiener diversity index was 2.51, and the Pielou equitability index was 0.66. This work seeks to promote research on biological communities, because these studies are the basis for full knowledge about the species that exist in a particular location and, enables us to create and implement management plans for conservation of marine protected areas.

A REASSESSMENT OF THE PHYLOGENY OF POLYGYRIDAE BASED ON ANALYSES OF A MULTIGENE DATA SET

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Polygyridae is a large clade of terrestrial North American snails comprising ~400 species, three of which are known to be federally endangered and five of which are considered to be problematic invasive species. Even though polygyrids are among the most commonly encountered and visible of the native North American land snails, phylogenetic relationships within Polygyridae remain poorly understood. The current paradigm on polygyrid relationships was established by Emberton using morphological characters. While Emberton's work represented a major increase in our understanding of polygyrid evolution, a reassessment of both species- and higher-level phylogeny of Polygyridae based on molecular characters is needed. To generate a phylogenetic hypothesis for Polygyridae based on DNA sequence data, we sequenced regions of four mitochondrial (12S, 16S, COI and cytochrome b) and two nuclear (28S and histone H3) genes from hundreds of specimens representing many species and all but two polygyrid genera. These data were combined with all publicly available data for these gene regions from sigmurethrans and analyzed using maximum likelihood methods. Preliminary results support monophyly of some tribes (e.g., Mesodontini, Polygyrini) but not others (e.g., Allogonini), and relationships among some tribes that are at odds with Emberton's hypothesis (e.g., a close relationship between Triodopsini and Mesodontini). Implications of these findings for polygyrid classification, as well as preliminary results of ancestral state reconstruction for particular characters of interest, will be discussed.

OPISTHOBRANCH ASSEMBLAGES IN THE MUDDY BOTTOMS OF THE RÍA DE ALDÁN (GALICIA, NW IBERIAN PENINSULA)

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Knowledge of soft-bottom opisthobranch assemblages in many areas is still scarce when compared to other molluscs such as bivalves. The Ría de Aldán is a small embayment on the NW coast of the Iberian Peninsula, belonging to a group of tectonically-formed estuaries named Rías Baixas. Its inner part is characterized by muddy bottoms with a high content of organic matter. Two sampling stations in that part of the embayment were studied from May 1998 to May 1999, and here we compare the opisthobranch fauna found in each of them. In each station, five replicate samples were taken monthly by means of a Van-Veen grab ($0.056m^2$) and then sieved through a 0.5 mm mesh. Benthic fauna present in the samples was sorted, and all the opisthobranchs were identified and counted. An additional sample was taken to determine sediment characteristics. Physico-chemical variables of water and sediment were also measured by means of a portable microprocessor.

A total of 585 individuals belonging to 17 different taxa were found, with *Cylichna cylindracea* (Pennant, 1777) the most abundant at both sites. Total abundance was similar in both stations, while diversity was higher in the innermost one, which presented the highest contents of both mud and organic matter. This site accounted for a total of 13 taxa, 7 of which were found only in this station. Otherwise, the outer site appeared to be more stable through time in terms of both total abundance and number of species. Anyway, most of the taxa found were rare ones, with more than half of them present in only one or two months for each of the sites.

TEMPORAL DYNAMICS OF *CYLICHNA CYLINDRACEA* (PENNANT, 1777) IN ESTUARINE MUDDY BOTTOMS

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Cylichna cylindracea (Cephalaspidea, Cylichnidae) is a common inhabitant of sublittoral fine sand and muddy bottoms and has been reported from coastal waters all around the world, especially in the northern Atlantic. However, despite its abundance and wide distribution, its ecology remains poorly known. A population of *C. cylindracea* was studied throughout a period of 13 months in two muddy bottoms inside a little embayment on the NW coast of the Iberian Peninsula. In each of the sites, five replicate samples were taken monthly by means of a Van-Veen grab, so covering a total area of 0.28 m^2; samples were sieved through a 0.5 mm mesh. Benthic fauna present in the samples was sorted using a stereo-microscope. An additional sample was taken to determine sediment texture and composition. Physico-chemical variables of water and sediment were also measured by means of a portable microprocessor.

Temporal dynamics of *C. cylindracea* differed between the two sites, although they presented some similarities, i.e. a spring peak of abundance following a more or less pronounced decrease during winter. Total abundance was higher and more stable through time in the outermost station. In the innermost station, which is muddier and with higher organic matter content, the species showed higher variability in abundance. The fact that the observed patterns are similar to those of other species studied in the same period for each of the stations, suggests that these patterns are likely the consequence of the influence of environmental factors. This would mean that the temporal fluctuations related to the very own life cycle of the species would be partially masked. Other factors (e.g. availability of prey) could also be involved, but this needs to be further investigated.

INFERRING SPECIES LIMITS IN FACULTATIVELY AUTOGAMOUS SLUGS AND SNAILS: A PROBLEM WITH TOO MANY SOLUTIONS?

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With the current popularity of DNA barcoding as a tool to delimit species, there is a renewed interest in species concepts and their role in underpinning taxonomy as an hypothesis-driven scientific discipline. Yet, with currently >25 different species concepts, it is usually unclear under which concept(s) new species are described. Hitherto, a vast majority of animal species have implicitly been described as morpho-species, which afterwards almost automatically have been regarded as biological species. This interpretative shift assumes that morphological differences between outcrossing taxa reflect reproductive isolation. Yet, facultatively selfing (autogamous) taxa, like several stylommatophoran snails and slugs, may produce deceivingly consistent phenotypic differentiation by the fixation of alternative alleles in different strains (multilocus genotypes). Obviously, such strains can easily be mistaken for morpho-species or biological species. Conversely, interpreting morphological differences among selfing strains as mere intraspecific polymorphisms ignores that such differentiation may reflect historical divergences that are consistent with the idea that species are evolving lineages.

The present contribution aims at exploring, illustrating and discussing this issue using two cases in point, viz. the decollate snails of the genus *Rumina* and the slugs of the arionid (sub)genus *Carinarion*. Based on morphology, anatomy, allozymes, DNA sequences, microsatellites and various species delimitation methods, we will show that for both taxa there may be (too) many taxonomic interpretations, a conclusion which reinforces the importance of referring to species concepts in taxonomic and/or DNA barcoding studies.

PHYLOGEOGRAPHY OF *SEPIOTEUTHIS LESSONIANA* (BIGFIN REEF SQUID) AND *UROTEUTHIS DUVAUCELI* (INDIAN SQUID)

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Sepioteuthis lessoniana (the bigfin reef squid) and *Uroteuthis duvauceli* (the Indian squid) are two loliginid squid species found in largely overlapping regions in the Indian and Pacific Oceans. Both species are important to fisheries, but very little taxonomic work has been done on either of them to date. Previous studies have suggested that *S. lessoniana* is actually a species complex; there are three species of "*S. lessoniana*" in Japanese waters alone. The similarly broad geographic range of *U. duvauceli* suggests that this species could also harbor substantial cryptic genetic diversity. In order to evaluate genetic variation within these two species, regions of two mitochondrial genes—the large subunit ribosomal RNA gene (16S) and the cytochrome oxidase I gene (COI)—were sequenced from specimens caught in Iranian (Arabian Sea and Persian Gulf) and south Indian waters as well as several sites in Indonesia and the Philippines. These data were combined with all available 16S and COI data in GenBank for *Sepioteuthis*, *Uroteuthis* and *Loliolus* (a close relative of *Uroteuthis*). Phylogenetic analyses showed that "*S. lessoniana*" comprises at least three genetically distinct lineages in the regions sampled in this study, and two of these lineages have broad, overlapping ranges. For *Uroteuthis duvauceli*, specimens from Iran are genetically distinct from those in Thailand and Japan, suggesting that *Uroteuthis duvauceli* may also be a species complex. Furthermore, phylogenetic analyses revealed that *Uroteuthis* (a clade of squid that bear paired bacterial bioluminescent organs on the ventral side of the ink sac) is paraphyletic with respect to *Loliolus* (a clade of non-bioluminescent squid). Ancestral state reconstruction suggests that bacterial bioluminescence evolved once in Loliginidae and was subsequently lost in the ancestor of *Loliolus*. This study is the first attempt to assess mitochondrial genetic diversity across the ranges of these two species; future work will require additional genetic markers and additional sampling from other geographic regions.

ECOLOGICAL NETWORK ANALYSIS OF THE FEEDING BIOGEOGRAPHY OF NUDIBRANCHS: INTER- AND INTRA-PROVINCIAL VARIATIONS

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Timed nudibranch-density studies were performed in four different central and eastern Pacific zoogeographic provinces: Hawaiian, Oregonian, Sea of Cortez and Mexican. Densities and relative percentages of species and specimens observed were compared with all known species recorded from each faunal province to determine the functional structures of nudibranch community networks. There were greater correlations of nudibranch abundances by feeding preference between provinces than from sites within a province. Diversity (Shannon-Wiener H'

and evenness) indices revealed contrasting patterns for bryozoan, cnidarian and sponge feeder abundances.

HISTORY OF OPISTHOBRANCH INVESTIGATIONS ALONG THE COASTS OF THE BAJA CALIFORNIA PENINSULA / HISTORIA DE LAS INVESTIGACIONES SOBRE OPISTOBRANQUIOS A LO LARGO DE LAS COSTAS DE LA PENÍNSULA DE BAJA CALIFORNIA

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Descriptions of opisthobranchs in the Sea of Cortez, excluding those based on empty shells, date from *Tridachia diomedea* Bergh, 1894, to *Peltodoris rosae* Valdés & Bertsch, 2010. During that time, 49 species have been named with type localities in the Sea of Cortez, and 183 valid species are now known to occur in this region.

Opisthobranch research efforts historically have been significantly different along the western shores of US–Canada and the shores of México's Sea of Cortez. Five periods of research were identified for the coastline between Alaska and the southern tip of the Baja California peninsula, with numerous species being named continuously since the 1830s. In contrast, opisthobranch investigations in the SC began with the Steinbeck & Ricketts report of their collections during March-April 1940. However, another 20 years would pass before research began in earnest.

In the 1960s Wes Farmer and James Lance named species they and their friends had live-collected from Baja California, and Ernst and Eveline Marcus described the large preserved collection sent to them by Peter E. Pickens from the University of Arizona's Sonoran marine research station. The floodgates had opened. In the 1970s and 1980s numerous new species descriptions (which included details on the living animals and their natural history) were published by Hans Bertsch, Terry Gosliner, Gary Williams, Dave Behrens and others. Research continues today, with new species still to be named and university students from UABCS conducting long-term field studies.

Bahía de los Ángeles (approximately 29ºN; 113º30`W), in the north-central portion of the SC, has been a major site of opisthobranch studies. Opisthobranch research in this area began with Steinbeck & Ricketts' (1941) first report of 4 species from Puerto Refugio, Isla Ángel de la Guardia. Today more than 80 opisthobranch species are known to occur here, and the type localities of 13 nudibranch species are within this region.

When Steinbeck & Ricketts wrote that "Puerto Refugio was a strange collecting place. The water was quite cold, and many of the members of both the northern and southern fauna occurred here," they astutely recognized the biogeographic patterns in the Sea of Cortez, with its diverse faunal components. It has a very low opisthobranch species endemism (5.5%); 53% of the species occur northward in the cooler-water Californian province, 79.8% occur in the Mexican/Panamic tropical provinces south, and 37.7% of the species occur both to the north and south of the Sea of Cortez.

Since 1984, I have been regularly monitoring the opisthobranch communities of Bahía de

los Ángeles. Using a timed-search sampling technique, I have analyzed the faunal biodiversity, annual and seasonal population variations, life cycles and reproductive periods of the frequently occurring species, contrasting abundances of species by feeding preference, interprovincial biogeographic relationships, and other ecological and taxonomic comparisons. This presentation also summarizes the spatial and temporal structures, interactions and variations found at Bahía de los Ángeles.

Las descripciones de opistobranquios en el Mar de Cortés, excepto las basadas en conchas vacías, datan desde Tridachia diomedea *Bergh, 1894, hasta* Peltodoris rosae *Valdés & Bertsch, 2010. Durante ese tiempo se han nombrado 49 especies con localidades tipo en el Mar de Cortés, y se sabe que 183 especies válidas ocurren en esta región.*

Históricamente, los esfuerzos de investigación de opistobranquios son significativamente diferentes a lo largo de las costas occidentales de EE.UU. y Canadá, que en las costas del Mar de Cortés en México. Se identificaron cinco periodos de investigación para la costa entre Alaska y la punta de la península de Baja California, con numerosas especies nombradas continuamente desde los 1830s. En contraste, las investigaciones de opistobranquios en el Mar de Cortés empezaron con el reporte de las colecciones de Steinbeck & Ricketts durante Abril-Marzo de 1940. Sin embargo, habrían de pasar 20 años antes de que la investigación empezara seriamente.

En los 1960s, Wes Farmer y James Lance nombraron especies de Baja California que ellos y sus amigos habían colectado vivas, y Ernst y Eveline Marcus describieron la amplia colección preservada que les enviara Peter E. Pickens desde la Estación Marina en Sonora de la Universidad de Arizona. Entonces se soltó el torrente: en los 1970s y 1980s se publicaron numerosas descripciones de nuevas especies (que incluían detalles de los animales vivos y su historia natural) por Hans Bertsch, Terry Gosliner, Gary Williams, Dave Behrens y otros. La investigación continúa actualmente, con nuevas especies por ser nombradas y estudiantes universitarios de la UACBS que realizan estudios de campo a largo plazo.

Bahía de los Ángeles (aproximadamente 29°N; 113°30'W), en la porción centro-norte del Mar de Cortés, ha sido un sitio importante para los estudios de opistobranquios. La investigación de opistobranquios en esta área empezó con el primer reporte de Steinbeck & Ricketts (1941) de 4 especies de Puerto Refugio, Isla Ángel de la Guarda. Hoy se conoce que aquí ocurren más de 80 especies de opistobranquios, y las localidades tipo para 13 especies de nudibranquios se localizan dentro de esta región.

Cuando Steinbeck & Ricketts escribieron que "Puerto Refugio era un extraño lugar para colectar... el agua estaba muy fría, y ocurrían aquí muchos miembros de la fauna tanto del norte como del sur", astutamente estaban reconociendo los patrones biogeográficos del Mar de Cortés con sus diversos componentes faunísticos. Tiene muy bajo endemismo de especies de opistobranquios (5.5%); 53% de las especies ocurren hacia el norte en las aguas templadas de la provincia californiana, un 79.8% ocurren en las provincias tropicales mexicana/panámica al sur, y un 37.7% de las especies ocurren tanto al norte como al sur del Mar de Cortés.

Desde 1984, he estado monitoreando regularmente las comunidades de opistobranquios en Bahía de los Ángeles. Usando la técnica de muestreo por tiempo/búsqueda, he analizado la biodiversidad faunística, las variaciones de población anual y estacional, los ciclos de vida y los periodos reproductivos de las especies que ocurren más frecuentemente, contrastando las abundancias de especies por preferencia alimentaria, relaciones biogeográficas interprovinciales, y otras comparaciones ecológicas y taxonómicas. Esta presentación también resume las estructuras espaciales y temporales, interacciones y variaciones encontradas en Bahía de los Ángeles.

PLANTS & VERTEBRATES, BUGS & SLUGS: THE CROSSING GEOGRAPHIC AND TAXONOMIC PATHS OF FIVE NATURALISTS

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Some 200 species of nudibranchs have been named from the northeast Pacific by numerous researchers who usually have been based on the Pacific North American coast and have specialized in nudibranchs and their allies (e.g., MacFarland, O'Donoghue, Lance, Farmer, Behrens, Gosliner and Millen to name a few).

However, there is a group of pioneer naturalists during the 19th and early 20th centuries who were exceptions to these place and taxa rules, five men born in three countries: Estonia, England and the United States. They named species of opisthobranchs and had them named in their honor. They all did field work in the northeast Pacific, but what makes them unique and the subject of this study, is that they had research interests in a wide diversity of taxa, including plants, cnidarians, annelids, barnacles, brachiopods, echinoderms, insects, fish, reptiles, birds and mammals. They all named (or had named in their honor) species in one or more non-slug taxa.

Johann Friedrich Eschscholtz (1793-1831) collected in California and Alaska when they still belonged to Spain, México, and Russia. He named the nudibranch *Hermissenda crassicornis* and the common northeast Pacific sand dollar, *Dendraster excentricus*. He also named two island terrestrial endemics, the Philippine bat *Acerodon jubatus* and the Hawaiian Kamehameha butterfly *Vanessa tameamea*. The genus of the California Golden Poppy, *Eschscholzia*, was named for him. After his circum-global expeditions, he returned to his birthplace, as a Professor at the University of Dorpat until his early death at 32 years of age on 19 May 1831.

Robert E. C. Stearns (1827-1909) was the 19th century equivalent of today's bi-coastal jet-setter, spending prolonged alternating periods on the U.S. east and west coasts. He worked four years as paymaster for copper mines in Michigan, then moved to California in 1858. As editor of the weekly Pacific Methodist, his advocacy for the Union cause helped influence the new-State citizens to stand by the Union during the Civil War. In 1862 he was appointed Deputy Clerk of the California Supreme Court, then went east to explore southwest Florida, again returning west where he was Secretary of the University of California and actively supported the California Academy of Sciences. In the 1880s he went back east, working at the U.S. National Museum until his death in 1909. W. H. Dall authored his obituary in Science. Stearns named various mollusks from tropical west America and southern California (such as *Haliotis walallensis*, *Casmaria vibexmexicana* and *Conus dalli*) and the festive alcyonarian-eating nudibranch *Tritonia festiva*. The spotted croaker fish *Roncador stearnsi* (the genus is from the Spanish word for "snorer") and an aeolid nudibranch (Cockerell's *Austraeolis stearnsi*) are named for him.

James Graham Cooper (1830-1902) was born in New York City, the first son of Mary and William Cooper. His father was himself a respected naturalist and ornithologist, naming the Evening Grosbeak *Coccothraustes vespertinus* and the bat *Plecotus townsendii*, and he was honored with Cooper's Hawk, *Accipiter cooperi*. James Graham grew up on a farm, meandering

through the woods and fields on his way to school, observing and collecting bird nests, shells and reptiles. After graduating from the College of Physicians and Surgeons, he practiced medicine at the city's hospital from 1851-1853. He was then appointed Physician and Naturalist for the 1853-1856 Railroad Survey Expedition in the Washington Territory (land newly-acquired from Britain in 1846). Throughout the rest of his life, medicine offered the means to pursue his passion and second career as a naturalist.

Dr. Cooper's military service included Army Cavalry expeditions throughout the mountains and deserts of the northwest and southwest and across the Plains and the Rockies. He billeted at Jefferson Barracks in St. Louis, and at Forts Benton, Leavenworth, Laramie, Vancouver and Mojave, among others. On the railroad survey he was commanded by Captain George B. McClellan, who later led the Union troops at Antietam, 17 September 1862, the bloodiest day of the Civil War. Also on that expedition, he met Lieutenant Ulysses Simpson Grant, the Quartermaster at Ft. Vancouver. Throughout it all, he was always collecting and in correspondence with scientific colleagues (especially with Spencer Fullerton Baird). He would return to cities, working at museums like the Smithsonian Institution, Philadelphia's Academy of Natural Sciences, and the California Academy of Sciences. He named nudibranchs—eleven valid species, such as the foudroyant *Flabellina iodinea* and *Janolus barbarensis*—plus land snails, the stingray *Urolophus halleri* (after his military commander at Ft. Mojave), two birds (Lucy's warbler *Vermivora luciae*, after the daughter of the Smithsonian's S. F. Baird, and the elf owl *Micrathene whitneyi*, in honor of his friend Josiah Whitney, the State Geologist of California, for whom Mt. Whitney is also named), the "slow-moving" desert tortoise *Gopherus agassizii*, after the "slow-thinking" anti-Darwinist Harvard professor, Louis Agassiz, and various other species. One nudibranch is named for him, *Flabellina cooperi* (Cockerell, 1901). J. G. Cooper is the subject of Eugene Coan's (1981) marvelously entertaining and well-researched biography, A Pioneer Western Naturalist.

William Healey Dall (1845-1927) was a profligate namer of species. Boss, Rosewater & Ruhoff (1968) catalogued 5,302 molluscan and 125 non-molluscan species introduced by Dall; these numbers were not corrected (reduced) to the species that are not synonyms of earlier taxa. Of this vast number, *stearnsii* ranks as Dall's 8th most common species' name proposed (17 times), including the volutid gastropod *Arctomelon stearnsii*. In contrast, he named 4 species honoring Cooper (one considered valid), and one each for Eschscholtz and Cockerell. Dall is the only person both to have named (*Haliotis assimilis* Dall, 1878) and to have been named for (by Henderson, 1915), a species of *Haliotis*. He named three northeast Pacific opisthobranchs, *Phyllaplysia taylori*, *Berthelinia chloris* (the bivalved sacoglossan, which he had thought was a clam based on the empty shells he had examined), and *Berthella californica*. Rudolf Bergh named *Dendronotus dalli* in his honor. It should be noted that Bergh only had the "bulbus pharyngeus" (buccal mass) as type material; the rest of the animal was unavailable and unknown to him. Dall named the genus and species of the barnacle *Cryptolepas rachianecti* that lives only on the California gray whale. The three species of cetacean he named are synonyms of prior names, although the odontocete species of *Phocoenoides* named in his honor by True (1885) is valid. Dall's sheep (*Ovis dalli* Nelson, 1884) is also valid, readily distinguished from the allopatric bighorn sheep and mountain goat.

One can simply categorize Dall's career into three main periods: survey expeditions to Alaska (1865-1870, before and after the US purchased it from Russia; note however, that his field work in Alaska continued into the other periods), with the US Coast and Geodetic Survey (1870-1885), and as Honorary Curator of Invertebrate Paleontology at the United States National

Museum (1885 to his death in 1927). Revealingly, Robert E. C. Stearns was his contemporary at the U.S. National Museum as an Assistant Curator in Malacology (1884-1909). During his expeditions to Alaska, Dall sailed on the clipper *Nightingale*, which was commanded by the whaler Charles Melville Scammon, and he worked with John Muir on glaciers.

Theodore Dru Alison Cockerell (1866-1948) lived most of his professional life in New México and Colorado, but traveled widely, with trips to Jamaica, Australia and Argentina. He was in Japan during the Great Kantu Earthquake of 1923, which devastated Tokyo and Yokohama. Similar to the San Francisco Earthquake of 1906, the majority of deaths were fire related. This 7.9 quake also generated a tsunami of 10 m, which struck the coast of Sagami Bay, where later Emperor Hirohito colleeted the nudibranchs described, illustrated and named by Kikutaro Baba in 1949 and 1955. In 1927 Cockerell crossed Russia on the Trans-Siberian Railroad. Primarily working as an entomologist, he studied insect pests and their biological control, the life and habits of bumblebees, scale insects (and fish scales!), and ants. Cockerell named various U.S. west coast nudibranchs (including *Felimare porterae*) and had one named for him, *Limacia* [formerly *Laila*] *cockerelli*. Numerous ant species and a potato scyllid (close to a real bug, but it is an homopteran, not an hemipteran) are named in his honor.

The crossing paths of these five naturalists may have been summarized best by T.D.A. Cockerell, who wrote in 1935: "The scientific man is always on the road, never at the journey's end." Or as my granddaughter Ivette Cadena told me once on a dusty dirt road in Baja California, "*Si encontramos algo nuevo, podemos explorar*!" If we encounter something new, we can explore!

A MOLECULAR EYE ON *NIPPONARION* (STYLOMMATOPHORA: ARIONIDAE)

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The taxonomy and phylogeny of the terrestrial (semi)slug family Arionidae (*sensu lato*) are still poorly known. Particularly, the subfamilial and generie composition of this family is in a state of confusion, up to the extent that several recent authors have split the group by raising its former subfamilies to family rank. Also the assignment of genera to arionid (sub)families is often problematic. A case in point is the rare, endemic Japanese genus *Nipponarion* with its single species *Nipponarion carinatus* Yamaguchi & Habe, 1955. According to its original description, *Nipponarion* would be most closely related to the North American genus *Prophysaon* and thus would belong to either Ariolimacidae or Anadenidae, depending on where authors place *Prophysaon*. Alternatively, *Nipponarion* was not eonsidered to be closely related to *Prophysaon*, but instead was assigned to Arionidae *s.s*. These alternative points of view also imply different zoogeographic interpretations.

Against this background we attempted to reconstruct the phylogenetic relationships of *N. carinatus* by determining nucleotide sequences of the nuclear ribosomal stretch including ITS-2 plus a part of the 28S rDNA, and of a fragment of the mitochondrial COI gene. These data were aligned with similar data of a wide range of arionoid and many other stylommatophoran taxa, and subjected to phylogenetic analysis. The preliminary results of this work show that *N. carinatus* does not belong to Arionidae *s.s.*, but that it nevertheless tends to group with an unresolved and poorly supported cluster of Arionoid taxa.

MOLECULAR REGULATION OF CHITON RADULA BIOMINERALISATION

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The chiton radula is a unique structure for the study of biomineralisation due to the sequential deposition of a range of iron and calcium minerals into the radula teeth in precisely controlled locations. While the minerals associated with chiton radula teeth have been well characterised and much is known about the cellular delivery of ions to the tooth cusps, much less is understood about the organic matrix which mediates the biomineralisation process and provides a scaffold for mineral deposition. While there has been considerable research on biomineralisation processes in the radula teeth of chitons, and the biominerals and matrix have been characterised to some degree, there have been no documented studies undertaken on the molecular regulation of biomineralisation in the chiton radula. A microarray, transcriptomics and *in situ* hybridisation approach has been utilised to undertake a molecular investigation of gene expression in the radula sac of the chitons, *Acanthopleura hirtosa* and *A. gaimardi*. A number of genes with appropriate biomineralisation related functionality have been isolated, and their differential expression illustrated across the various stages of biomineralisation in the radula. While there is a substantial way to go in understanding the molecular regulation of biomineralisation in the chiton radula, this study provides new insights into the complexity of the process and identifies some genes with putative biomineralisation functionality.

ANCIENT MOTHER-OF-PEARL BREASTPLATES FROM ENSENADA DE MUERTOS, BAJA CALIFORNIA SUR, MÉXICO / PECTORALES DE CONCHA NACARADA DE LOS ANTIGUOS CALIFORNIOS DE ENSENADA DE MUERTOS, BAJA CALIFORNIA SUR, MÉXICO

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During the course of Instituto Nacional de Antropología e Historia (INAH) excavations in 2003 and 2009 at Ensenada de Muertos, mother-of-pearls ornaments were found in association with burials. The collection of 30 pieces was analyzed morphometrically to understand the

manufacturing techniques of the shell items, and to present an appropriate hypothesis. The studied ornaments share the features of those made from *Pinctada mazatlanica* valves or mother-of-pearl. Four types of breastplates were identified. The first had a burnished sheen. The principal attribute of the pear-shaped bi-conic perforations in the upper region is its detachment from the nacre covering, having a shape formed by working against harder objects, such as lithics. In addition to polishing, the second type found was embellished with circular-conical, interrupted engravings, arranged in parallel bands on the interior part of the worked valves. There is also a bi-conic superiorly-placed perforation, with a flattened triangular form. The third type consists of smaller forms, fragile ornaments, all bordered with a workmanship that is polished and distinguished by its particularly delicate shape. The last type includes large, pear-shaped breastplates, covered with a layer of ochre pigment as a secondary decoration, presenting a notably burnished sheen.

The manufacture of these ornaments was by percussive techniques that shaped and perforated the shell valves. Then were applied the finishing touches of polishing, burnishing and engraving. The analyzed materials show obvious marks resulting from applying the above-mentioned percussive techniques. These suggest that the principal materials used in their manufacture were lithic in origin. The breastplates found among the burials are covered with an ochre pigment, probably having been applied to the bones during exhumation, typical of the ancient Californian culture.

Finally, we analyze and discuss the importance of mother-of-pearl shells in making adornments, the use of pearls in this tradition, as well as other species of bivalves and gastropods that are found associated with such daily-life activities as making tools and container vessels.

Durante las excavaciones realizadas por el personal del INAH en 2003 y 2009 en la localidad Ensenada de Muertos, Baja California Sur, fueron encontrados ornamentos de concha nacarada, asociados a entierros, la colección de 30 piezas fue analizada morfo metricamente a fin de relacionar los artículos de concha con técnicas de elaboración y poder presentar una hipótesis de sus significados. Los ornamentos analizados se concretaron a aquellos elaborados a partir de las valvas de la especie Pinctada mazatlanica *o madre perla. Cuatro tipos de pectorales fueron identificados; los primeros, pulidos por bruñido con una perforación superior en forma periforme, en donde destaca su capa nacarada como atributo principal, con una forma lograda por tallado contra objetos de mayor dureza, presumiblemente líticos, con perforaciones bicónicas. Los segundos pectorales que además del pulido presentan ornamentos por esgrafiado de forma circular cónica, dispuestos en bandas paralelas adornando la parte interna de las valvas talladas, también con perforación bicónica en la parte superior de una forma triangular achatada. Los terceros, formas de menor superficie, todas acerradas en sus bordes también por tallado, pulidas y destacadas por su forma particularmente delicada, que constituyen ornamentos frágiles. El último tipo son pectorales de forma periforme de mayor tamaño, cubiertos con pasta con pigmento ocre como decoración secundaria, que presentan un pulido por bruñido notable.*

La manufactura de los ornamentos fue lograda por la aplicación de las técnicas de percusión, desgaste y perforado, así como por la aplicación de técnicas de acabado pulido, bruñido y esgrafiado. Los materiales analizados presentan marcas profundas resultantes de la aplicación de las técnicas mencionadas sugiriendo que los principales materiales usados en la manufactura fueron de origen lítico. Los pectorales rescatados en los entierros están cubiertos

de pigmento de color ocre, probablemente aplicado a los restos óseos durante la exhumación, típica de la cultura de los Antiguos Californios.

Se destaca y discute la importancia de las conchas nacaradas para la elaboración de ornamentos, así como el uso de perlas por esta cultura, mientras que otras especies de bivalvos y gasterópodos se encuentran asociadas a actividades de la vida diaria, como la fabricación de instrumentos y recipientes contenedores.

VARIATIONS ON CALCIFICATION MICRO BANDS FORMED DURING THE SHELL GROWTH OF *PTERIA STERNA* JUVENILES

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In México, the commercial culture of the winged pearl oyster *Pteria sterna*, relies on the collection of juveniles from the wild. The recruitment process includes a three or four month growth period in the sea, until they reach the suitable size for being handled. Unfortunately during this period many juveniles are lost. In order to understand and solve the problem, we studied, in the collected juveniles, their growth relationships with environmental parameters and food availability. The juveniles were collected on plastic filament contained in plastic mesh bags, from two stations in La Paz Bay, during two periods; 17th December 2008 to 8th April 2009 and 8th April to 1st July 2009. At the end of each collection period the collected juveniles were dried, weighed and then their shells were separated from the tissues and stored individually. The shells were measured in length and height, then they were cut along their major axis (anterior-posterior) from the umbo to the distal shell edge using a low speed cutter provided with diamond knife, the shell cuts obtained had an average thickness of 320 μm, every cut was glued with cyanoacrylate to a glass slide and polished for observation under the microscope in order to count the micro growth bands and measure their correspondent length. The identification of daily growth bands was validated by fluorochrome calcein marker in pearl oysters juvenile shells. Daily satellite photos from SeaWiFS Ocean Color for the study period were used for extrapolating the chlorophyll. Direct water samples from the stations in La Paz Bay were analyzed every month for the determination of PIM, POM. The temperature was recordered daily in a digital thermograph located in the Bay.

The individual average length of the micro bands of calcification have a variation range for the spats collected in the first period from 59.9 ± 12.9 μm per day to 91 ± 19.7 μm and for the second period of 73.3 ± 15.3 μm to 95.6 ± 11.7 μm per day. Nine individuals were measured for the first period obtaining one specimen with 150 bands as a maximum number and 70 for the youngest animal collected. Twelve animals were measured in the second period, with 158 bands and 77 bands. The average in band length per animal per period did not show significant differences: 82.8 μm; $F = 1.9739$; $p<0.05$ (ANOVA) for the first period, and for the second, 84.4 μm; the result of ANOVA was not significant $F = 1.8162$; $p<0.05$. For the study of environmental parameter relationships we used only the 30 last length measurements per animal, in order to have similar days to compare, with the records of each parameter. No relation was found for temperature ($y = 0.0077x + 20.668$; $r^2 = 0.02$), nor for chlorophyll ($y = 0.0032x + 4.901$; $r^2 = 0.0016$), the relationship with PIN and POM were discussed, in conclusion the length

of daily micro growth bands in juvenile shells have a natural length average of 83.6 μm, with a natural variation coefficient of 30.5%.

PARTICULAR FEATURES OF GONADAL MATURATION AND SIZE AT FIRST MATURITY IN *ATRINA MAURA* (SOWERBY, 1835) (BIVALVIA: PINNIDAE)

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The gonadal maturation of *Atrina maura* was examined by means of histological analysis and using quantitative criteria. Particular features not previously described for this species are reported in this study: absence of the undifferentiated stage and massive gamete resorption, in both males and females, when water temperature reaches 25°C; in males, a continuous spawning concurrent with other gonadal development stages and adipogranular cells surrounding acini walls decreasing with testis ripeness, which suggest an energetic role. Atresia displayed two stages: cytoplasmic structures with oocyte degeneration, and digestion by hemocytes. Oocyte diameter was larger than those reported for cultured specimens. Spawning was present only when the tide was either rising or falling. Size at first maturity was 23.3 cm SH (12.2 cm SL) in females and 22.8 cm SH (12.0 cm SL) in males.

RESOLVING A THIRTY-YEAR-OLD HYPOTHESIS: IS *BERGHIA* A JUNIOR SYNONYM OF *SPURILLA*? A MORPHOLOGICAL AND MOLECULAR APPROACH

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The aeolid genus *Berghia* was erected by Trinchese in 1877, with *Berghia coerulescens* (Laurillard, 1830) as the type species. This genus is characterized by the possession of papillate rhinophores and cerata arranged in arches. Bergh (1864) erected the genus *Spurilla* based on the presence of perfoliate rhinophores, with the cerata also arranged in arches. Nevertheless, Rudman (1982) stated that differences between the genera *Berghia* and *Spurilla* were not significant enough to support both taxa as separate genera, considering the former as a junior synonym of *Spurilla*. Different authors followed this hypothesis during the last thirty years, but this synonymy has not been widely accepted. The controversy remains at the present and consequently the number of species that constitute the genus *Berghia* is still unclear. In this contribution we conduct a preliminary review of the genus *Berghia* and test Rudman's hypothesis through the study of their phylogenetic relationships based both on morphological and molecular data.

WHAT IS *SPURILLA NEAPOLITANA*? A NEW ANSWER TO AN OLD QUESTION

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Spurilla neapolitana, the type species of *Spurilla* Bergh, 1864, has been studied in depth by several authors (Bergh, 1877; Trinchese, 1878; Bergh, 1882; Vayssière, 1888; Engel, 1925; Pruvot-Fol, 1954; Swennen, 1961; Marcus and Marcus, 1967; Bebbington and Thompson, 1968; Gosliner, 1979; Schmekel and Portmann, 1982; García and Cervera, 1985; Dominguez *et al.*, 2008; García *et al.*, 2008 among others). According to the literature, the intraspecific variation in the denticulation of the jaws, the shape of the central cusp and the variation in coloration are widely accepted. This led to consider several names given to specimens from different Atlantic areas as synonyms of *Spurilla neapolitana,* and even to consider its presence in the Pacific Ocean (Gosliner, 1979; Camacho-García et al., 2005). However, our results confirm the existence of three cryptic species under the name *S. neapolitana,* and reject its amphiatlantic status. In this contribution we conduct a preliminary review of the species *Spurilla neapolitana* based on morphological and molecular analyses.

THE MATING BEHAVIOUR OF *VERONICELLA SLOANII* (CUVIER, 1817) IN BARBADOS.

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Veronicella sloanii (Cuvier) is the most common pest slug on the island of Barbados, but little is known about the biology of this systellamatophoran mollusk. The mating behaviour of the species was studied using *ad libitum* and focal animal sampling in a laboratory setting. The smallest individual observed mating had an extended length of 41.3 mm. Individuals mated in pairs or, less frequently, in threes. Mating involved a short courtship stage and a copulatory stage of much greater duration. During copulation slugs used the penial papilla to stroke the hyponotum of the mating partner.

THE HISTORY OF MARINE BIVALVE RESEARCH IN THE PANAMIC PROVINCE

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The tropical west American molluscan fauna of the Panamic Province received delayed attention from the European scientific community compared to many other parts of the world. While a scattering of specimens from individual collectors were described long ago by such authors as Linnaeus and Lamarck, it was only after the 1801-1803 expedition of Humboldt and Bonpland, who stopped briefly at Acapulco, México, that more Panamic material started to fall into the hands of European authors.

Collecting in the early 19th century by Hugh Cuming yielded large numbers of bivalve specimens and subsequently led to new species descriptions by Broderip, the G.B. Sowerby's I and II, Reeve and Hanley. C.B. Adams collected on the west coast of Panama in 1850, and in 1852 published a book devoted to that fauna, including descriptions of many new bivalve taxa. Phillip P. Carpenter obtained a substantial collection of mollusks from Frederick Reigen from in and around Mazatlán, México, between 1848 and 1850. This resulted in an entire volume in 1857 on the Panamic fauna and provided significant contributions to understanding of the regional bivalves.

The center of work on American taxonomy then shifted to the eastern United States, where William H. Dall at the United States National Museum, became the pre-eminent authority and described more than a thousand species of mollusks from the eastern Pacific, many as a result of dredging by the U.S. Fish Commission steamer *Albatross*.

Subsequently, bivalve taxonomy flourished on the West Coast itself, particularly at the California Academy of Sciences, the San Diego Natural History Museum, the Allan Hancock Foundation at the University of Southern California, the Santa Barbara Museum of Natural History, and the Los Angeles County Museum of Natural History.

The first effort to discuss the entire Panamic bivalve fauna was that of Hertlein & Strong in the 1940s and 1950s. Myra Keen's books then treated the entire Panamic molluscan fauna in 1958 and 1971, and Olsson discussed the bivalves of the southern part of the province in 1961.

Our recent effort started with Keen's 1971 book (and Skoglund updates), Olsson's 1961 book, and Frank Bernard's checklist of 1983, as well as the relevant literature about each family. The new volume on the Panamic Bivalvia (Coan & Valentich-Scott, 2012) includes descriptions and illustrations of 890 species, along with details of their habitat and distribution. Sixteen new species are described, along with three new genera. In spite of the voluminous amount of data presented in the publication, many questions remain to be resolved.

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SORTING OUT THE *SIPHONARIA*: REVIVING OLD NAMES FOR DNA-DELIMITED SIPHON LIMPETS

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Like all marine limpets, the siphon limpets (*Siphonaria* spp.) are prone to phenotypic plasticity and seashore shell erosion. In the eastern Pacific, Hugh Cuming (1791-1865) was among the first to collect them along with countless other marine Mollusca on the shores of Panama and elsewhere on his famous expeditions. English and European "armchair" shell enthusiasts were eager to describe his collected shells and many did. Later, Philip Pearsal Carpenter described many more species, including some new names for *Siphonaria*, in his landmark study of a massive Matzatlan shell collection. These and other early names are intertwined in a convoluted history of naming and synonymy of names leading up to the present, and this has been confounded by the difficulty in associating shells in far away museum cabinets with Pacific shore animals. Armed with new opportunities to employ DNA sequence comparisons to sort out such complex groups of species, it has become somewhat easier to estimate the number of species and their distributional patterns, and many of the earliest descriptions are now readily available for download on the Internet. However, it remains a challenging but necessary task to study the history of names and their correspondence to available type material, and difficult to say for certain how these type specimens relate to species estimated from morphological and molecular study. I have recently undertaken a combination of collaborative field, morphological, and molecular studies of siphon limpets in three Pacific regions: the Panamic province, further north on the temperate islands off the coast of southern California and Baja California, and the Hawaiian Islands. Molecular data sets (mitochondrial 16S and COI genes, and nuclear H3) have been effective in helping us delimit natural clades of siphon limpets. The emphasis of this talk will be on how, with much help from others, I was able to associate my molecular voucher specimens with some of the oldest available historical type material, including some that had long been considered junior synonyms, and this led to progress in understanding our sampled populations of living siphon limpets in our study areas.

SYSTEMATICS, BIOGEOGRAPHY AND SPECIATION OF THE DEEP-SEA GENUS *SCAPHANDER* (GASTROPODA, CEPHALASPIDEA) IN THE ATLANTIC OCEAN

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The genus *Scaphander* is a group of deep-sea, soft-bottom snails distributed worldwide from the Arctic to the Antarctic with approximately 45 species described. The number of valid species in the Atlantic is disputed and no review is available. Moreover, knowledge about deep-sea biodiversity, biogeography and speciation processes is very limited and no complete molecular phylogenies are known for deep-sea groups of benthic invertebrates.

Here we present a systematic revision of the Atlantic species based on an integrative taxonomic approach combining the study of shells, morpho-anatomical characters, and molecular Bayesian phylogenetics. Eight species have been recognized as valid in the Atlantic; two species are restricted to the northeast Atlantic (*S. gracilis*, *S. lignarius*), three species have amphi-Atlantic distributions (*S. bathymophilus*, *S. nobilis*, *S. punctostriatus*), and three species are restricted to the western Atlantic (*S. clavus*, *S. darius*, *S. watsoni*).

In order to test hypotheses about deep-sea diversification in the Atlantic Ocean, a fossil calibrated phylogeny including six Atlantic (75% of total diversity) and three Indo-Pacific species was inferred based on the mitochondrial COI and 16S rRNA and nuclear 28S rRNA genes.

The Atlantic species-group is polyphyletic with multiple sister-relationships between Atlantic and Indo-Pacific lineages caused by the closure of the Tethys seaway. A proportionally high percentage of amphi-Atlantic species was found (ca. 40% of Atlantic diversity). This is hypothesized to be maintained via dispersal along the Arctic/sub-Arctic shelf and slope and via reproductive populations on the abyssal sea floor. Dispersal around South Africa is predicted to explain post-Tethyan speciation between Indo-Pacific and Atlantic lineages, but the different faunal composition of both oceanic basins shows that barriers to dispersal at high latitudes must exist in the deep-sea and that the possibility for dispersal is a rare event. There is only one example of sympatric sister species, suggesting that the major mode of speciation is allopatric and no direct evidence of ecological speciation was found.

Trophic relationships were assessed by gut content analysis. *Scaphander* mainly feeds on foraminiferans, including the distinctive agglutinating forms with hard tests. It is hypothesized that *Scaphander* are specialized feeders on animals with hard shells/tests, and their large, strong gizzard plates are an adaptation to this mode of feeding.

MOLECULAR SYSTEMATICS OF BANANA SLUGS (STYLOMMATOPHORA: ARIONIDAE: *ARIOLIMAX*)

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The genus *Ariolimax* is popularly known as banana slugs. These large slugs are found throughout the Pacific northwest of North America, from southeast Alaska to southern California. On the basis of genital morphology, the genus is currently divided in two subgenera (*Ariolimax s.s.* and *Meadarion*) with five (sub)species: (1) *A. (A.) columbianus columbianus* (Gould, 1851) (southeast Alaska to central California), (2) *A. (A.) c. stramineus* Hemphill, 1891 (south-central California), (3) *A. (M.) dolichophallus* Mead, 1943, (4) *A. (M.) californicus californicus* Cooper, 1872, and (5) *A. (M.) c. brachyphallus* Mead, 1943. The latter three taxa are more or less allopatrically distributed on the San Francisco Peninsula.

Recent studies of the genital anatomy and reproductive behavior of *Ariolimax* species have suggested that the genus has undergone a rapid evolutionary divergence, so that the current taxonomy of the genus needs to be re-interpreted. Therefore, we analyzed three mtDNA gene fragments (COI, 16S rRNA and CytB) in order the construct a molecular phylogenetic framework for the genus. The sequence analysis of the three concatenated fragments yielded four well supported clades in the subgenus *Ariolimax*, which were interpreted as four phylogenetic species corresponding to *A. columbianus* (southeast Alaska to north California), *A. buttoni* (Pilsbry & Vanatta, 1896) (= *A. columbianus* in north-central California), *A. stramineus,* and an undescribed species from Mount Palomar (San Diego County). The subgenus *Meadarion* comprises two clades, one including an undescribed species from Freamont Peak (San Benito County), the other including *A. brachyphallus*, *A. dolichophallus* and *A. californicus*. However, whereas *A. brachyphallus* is well supported as a clade, *A. dolichophallus* and *A. californicus* are not, even if they show differences in their genitalia and reproductive behavior.

In conclusion, current mtDNA, morphological and behavior evidence suggests that there may be at least eight species level taxa in the genus *Ariolimax*.

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DIFFERENT MODES FOR DIFFERENT FOLKS: AN INVASIVE GASTROPOD AND A SULFUR OXIDIZING BIVALVE AROUND TWO SAN DIEGO SEWAGE OUTFALLS

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The city of San Diego performs extensive environmental monitoring of the soft bottom benthos as part of its National Pollutant Discharge Elimination System (NPDES) permits for its two sewage outfalls. This generates a wealth of long-term data on community composition and distribution. Questions remain about the potential influence of these wastewater outfalls on the soft bottom community. Possible indicators of adverse effects are heightened populations of 1) invasive species such as the cephalaspidean *Philine auriformis* due to opportunistic exploitation of a disturbed environment or 2) bivalves with commensal sulfur oxidizing bacteria such as *Solemya pervernicosa* due to an expansion of reducing environments. The population dynamics of these two species of mollusks are examined in context with other environmental variables, distribution within the study area and other molluscan community indices.

TWO CRYPTIC SYMPATRIC SPECIES OF *COSTASIELLA* IN THE BAHAMAS EVOLVED ALLOPATRICALLY

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Costasiella ocellifera Simroth, 1895 is a species of sea slug (Mollusca: Gastropoda; Sacoglossa) that is found throughout the Caribbean. This species feeds exclusively on *Avrainvillea* green algae upon which is highly camouflaged. A preliminary phylogenetic analysis was constructed from nuclear (H3) and mitochondrial (16S, COI) gene sequences. It shows that several specimens identified as being *C. ocellifera* and collected from the Bahamas are genetically distinct from other specimens of *C. ocellifera* from the Bahamas and other western Atlantic locations. These genetically different specimens are considered to belong to a cryptic, undescribed species. The new species looks very similar (almost identical) to the typical *C. ocellifera* but a few differences in coloration and radular morphology provide additional support for molecular results.

Costasiella ocellifera and the new species are sister and sympatric in the Bahamas. Sister species with overlapping ranges, inhabiting areas in which there is no evidence of present or past biogeographic barriers to dispersal, could constitute potential cases of sympatric speciation. In this case, however, both species feed upon the same species of *Avrainvillea* and were collected in the same locations during the same time of the year. This seems to reject any possible niche partition or allochrony, which are common pre-requisites for sympatric speciation. Thus, we hypothesize that these two species evolved allopatrically. Lack of evidence of hybridization (no nuclear alleles of the new species are found in *C. ocellifera* or vice versa) suggests reinforcement.

This case is similar to other reported new cryptic species in the Bahamas (*Chelidonura*, *Philinopsis*, *Spurilla*) and provides further evidence of a partial or complete interruption of gene flow between the Bahamas and other Caribbean areas at some point in the past.

PERIODS FOR A ROTATING FISHING AREA STRATEGY FOR THE BLACK ARK SHELL IN ENSENADA DE LA PAZ, BAJA CALIFORNIA SUR, MÉXICO

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To explore the possibility of using a rotating fishing area strategy for the black ark shell *Anadara tuberculosa* (Sowerby, 1833), an experiment was designed to estimate density recovery time after intensive fishing. Two mangrove swamps, "El Conchalito" and "El Mogote," in the Ensenada de La Paz, were chosen as study sites. On each swamp, two areas were delimited for fishing and a third one was designated for repopulation. During October-November 2010 ark density (individuals/m^2) on each area was estimated. Between February-March 2011 fishing effort was applied to diminish density. Individuals caught were then transferred to the repopulation area. Densities and individuals' size were recorded from April 2011 through January 2012.

At "El Conchalito," mean density was 0.89 ind/m^2 (±0.19 s.d.), with a minimum of 0.52 ind/m^2 and maximum of 1.90 ind/m^2. The effect of intensive fishing was clearly observed at one of the fishing areas during the second and third bimonthly periods, but recovery of the initial density level took twelve months. At "El Mogote," average density was 1.76 ind/m^2 (±0.78 s.d.), with a minimum of 0.89 ind/m^2 and a maximum of 2.90 ind/m^2, and the effects of fishing were evident in both fishing areas; recovery of initial density levels took eight months. At the repopulation areas, densities increased from 0.35 to 1.32 ind/m^2 in "El Conchalito" and, from 0.93 to 2.45 ind/m^2 in "El Mogote."

Length frequency analyses showed a decrease in the number of large individuals and recruitment of smaller ones during the winter months. However, the cause of this is not well understood as ark shell recruitment behavior is not well known.

SPATIO-TEMPORAL VARIABILITY OF SOME SHALLOW-BOTTOM MACROINVERTEBRATES (GASTROPODA, BIVALVIA AND CEPHALOPODA) FROM ESPÍRITU SANTO ARCHIPELAGO, BAJA CALIFORNIA SUR, MÉXICO

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To identify spatiotemporal variation patterns in the structure of the rocky and sandy, shallow bottom macroinvertebrate community, two surveys (November 2011 and March 2012) were conducted at five sites around the Espíritu Santo Archipelago, Baja California Sur, México.

The abundance of conspicuous macrobenthos (gastropods, bivalves and cephalopods) was estimated visually by free diving at 4-6 m depth along two band-transects parallel to the coastline. Each transect was 5 m wide and 50 m long, covering an area of 500 m^2 per site. Sea surface temperature, wave exposure, type of substrate and slope were also recorded. Seventeen species were identified. The bivalves were best represented, with 9 species from 7 families, followed by the gastropods, with 7 species from 4 families, and one cephalopod. The highest mean abundance and density values were recorded for *Pinctada mazatlanica* (25.4 ± 16.7 ind and 0.05 ind m^2, respectively), *Pinna rugosa* (3.0 ± 3.08 ind and 0.008 ind m^2, respectively), and *Muricanthus nigritus* (2.6 ± 4.3 ind and 0.005 ind m^2, respectively). There were no significant differences in diversity, equitability and species richness among sampling months, though differences were found among sites ($P < 0.05$). A spatial diversity pattern was identified, with low values (Shannon H' = 0.42 bits ind^{-1} y J = 0.30) for exposed shores and high values (H' = 2.06 bits ind^{-1} y J = 0.86) for semi-sheltered areas.

WHAT'S UP IN THE CHUKCHI SEA: NEW AND OLD IMAGES OF ALASKA'S ARCTIC MOLLUSCAN FAUNA

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Between 1948 and 1950 George MacGinitie served as a principal investigator at the Naval Arctic Research Laboratory at Point Barrow, Alaska. He and his colleagues collected year round to understand the species diversity and life history of the nearshore marine invertebrates both east and west of Point Barrow in the Chukchi and Beaufort Seas. Several publications, including Nettie MacGinitie's Marine Mollusca of Point Barrow, Alaska, resulting from his tenure are still useful today for marine biologists working in the Alaskan Arctic. Nettie MacGinitie's publication describes and illustrates 107 molluscan species. In 1993 and again in 2010, and 2011, I participated in sampling in the northeastern Chukchi Sea. During these cruises, colleagues and I improvised live tanks and photographed many of the same species illustrated in MacGintie's publication. The genera *Margarites, Buccinum, Boreotrophon, Neptunea*, and *Oenopta* continue to challenge the molluscan taxonomists who sample the Arctic fauna. There is still a need for basic natural history and biogeographical information on the species present in the North American Arctic.

TESTING BIOGEOGRAPHIC AFFINITIES OF WEST COAST *CALLIOSTOMA* (VETIGASTROPODA)

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Calliostoma is a distinctive vetigastropod genus of about 250 extant species, and these have been the subject of recent broader molecular phylogenetic studies. However, *Calliostoma ligatum* is the only western North American species included in these studies so far, even though there are more than 10 species on this coast, most living at depths visited by scuba divers or

beachcombers. *Calliostoma ligatum* has been supported as sister taxon of a monophyletic grouping of eight northwestern Pacific (Japanese) members of this genus, and this result has been extended to predict that the northeastern Pacific *Calliostoma* in general are part of a temperate North Pacific radiation. However, many details remain to be investigated. For example, at one extreme, the northeastern and northwestern Pacific *Calliostoma* species assemblages could be reciprocally monophyletic, i.e., with parallel endemic radiations on either side of the North Pacific. This would imply that the considerable variation seen among West Coast species, for example in shell sculpturing, is a result of evolutionary divergence from a common ancestor, and any similarities particular species have with other worldwide species of *Calliostoma* would be better attributed to convergent evolution. At an opposite extreme, individual West Coast species might be relatively unrelated from each other and might differ substantially in their biogeographic affinities. For example, some might be more closely related to selected more tropical Panamic province species, and only distantly related to the co-occurring *C. ligatum* and also northwestern Pacific species. We are starting to test these possibilities by comparing DNA sequences of as many West Coast species of *Calliostoma* as we can obtain from our own collections or from museums. So far we have only obtained mitochondrial 16S and COI sequences of one additional species, the attractive *C. annulatum*. By analyzing these sequences along with all available *Calliostoma* 16S and COI sequences we have concluded that *C. annulatum* groups strongly (80% bootstrap support) with two Japanese species, *C. akoya* and *C. kiheiziebisu*, well apart from *C. ligatum*. Thus, we can already reject the hypothesis that all northeastern Pacific *Calliostoma* diverged from a single common West Coast ancestor.

GASTROPODS OF ACAPULCO BAY, GUERRERO, MÉXICO: SYSTEMATICS AND ECOLOGICAL INDEXES

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We studied the gastropod community in Acapulco Bay, Guerrero, México, in order to analyze the community structure in relation to two different substrates. Biological material was collected from 11 sampling stations in September 2008. Quadrants of 45 x 45 cm were used to obtain two samples of sandy substrate in each of the stations (11) and two samples at nine stations of rocky substrate. We determined a total of 9,440 individuals belonging to 184 species and 51 families, of which 71 corresponded to microgastropods and 47 species (25.54%) had living representatives. The families with the highest species richness were Columbellidae, Pyramidellidae, Caecidae and Fissurellidae. The highest values of density, species richness, diversity and taxonomic distinction were found in stations with sandy substrate, but not the higher values of equitability, which were found at stations with rocky substrate. According to the BVI, the dominant species in the area were: *Caecum quadratum, Rissoina effusa, C. bahiahondaense, Vermicularia frisbeyae, Crepidula aculeata, Rissoina stricta* and *Gibberula* sp. The faunal relationships between the stations with sandy substrate are grouped into two associations based on changes in species richness and density. It is suggested that the depth does not affect any of the ecological variables of the gastropod community (richness, density,

diversity and taxonomic distinction) due to narrow depth interval in which samples were collected.

A DARTLESS SPECIES OF *CAHUILLUS* (PULMONATA: HELMINTHOGLYPTIDAE) FROM THE MOJAVE DESERT, CALIFORNIA WITH A REASSIGNMENT OF *EREMARIONTA ROWELLI UNIFASCIATA*

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A new species of desert land snail in the family Helminthoglyptidae is described from the southern Soda Mountains in the Mojave Desert near the CSU Desert Studies Center at Zzyzx, California (near Baker). It is atypical for the genus, and helminthoglyptid land snails in general, by lacking a dart sac and associated mucus glands. Except for the large genus *Sonorella* Pilsbry, 1900 only a few helminthoglyptid species (mostly monotypic genera/subgenera) exhibit a dartless condition. There has been at least one proposal that all dartless species form a monophyletic group, but other authors have instead proposed multiple independent losses of the dart sac.

The new species is placed in genus *Cahuillus* Roth, 1996 based primarily on male genital characters, specifically aspects of its double-tubed epiphallus and verge. Two nearby species that show comparable shell and genital characters are *Cahuillus greggi* (Miller, 1981) and *Eremarionta rowelli unifasciata* (Willett, 1930). *Eremarionta r. unifasciata* is presently elevated to specific status and reassigned to *Cahuillus.* Both *C. greggi* and *C. unifasciata* are dart bearing.

The sequencing of mtDNA genes (16S and COI) for five species of *Eremarionta* Pilsbry, 1913 or *Cahuillus,* has produced results congruent with the morphological conclusions. A combined analysis of these genes supports the new species as distinct from the other available species (although *Cahuillus greggi* remains unavailable) and also supports its close relationship with *C. unifasciata.*

OPISTHOBRANCH GASTROPODS OBSERVED BY JAMES R. LANCE IN SAN DIEGO, 1953 – 2001

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Although Jim Lance's last paper concerning the distribution of California opisthobranchs was published in 1968, Jim continued surveying opisthobranchs near his home in San Diego County for another 33 years, keeping detailed records of his finds. Following his death in 2006, Jim's field accounts, 35 mm slides, and other research materials were donated to the California Academy of Sciences by Joan Steinberg, Jim's long-term friend and colleague. Recently, I requested the loan of Jim's California field records in order to digitize his long-term data and

make them more widely available to other researchers. Here, I summarize the remarkable contents of these field accounts for San Diego County and report on the status of this project.

Jim sampled eight intertidal sites spread over 23 km on the outer coast of San Diego, plus additional sites in Mission Bay. From 1953 to 2001, at the outer coast sites, Jim recorded approximately 29,000 individuals in 96 species - about one half the number of opisthobranch species known from the entire Californian and Oregonian biogeographic provinces combined. At South Casa Reef alone, Jim, together with numerous friends and colleagues, recorded 84 species. This is at least 50% more species than known from any other site in California or Oregon. In addition to highlighting this hotspot of biodiversity, the Lance data provide a solid baseline with which to evaluate long-term changes in the fauna, such as those related to climate change or the explosive growth in the last half of the 20th century of the San Diego/Tijuana metropolitan area.

NO MOLECULAR SUPPORT FOR A *DORIOPSILLA AREOLATA* BERGH, 1880 (MOLLUSCA: OPISTHOBRANCHIA) SUB-SPECIES SCHEME IN THE EASTERN ATLANTIC OCEAN

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The focus of this research was on using modern molecular techniques to infer the phylogenetic relationships between populations of the opisthobranch species *Doriopsilla areolata*, a nudibranch sea slug whose genus is characterized by a rigid and granulated mantle. *D. areolata* has a broad range that spans from Spain (southwestern Europe) to Angola (southwestern Africa) in the eastern Atlantic to the Caribbean. In 1997, a subspecies scheme proposed by Valdés separated individuals of *D. areolata* from specific geographic locations into subspecies: *D. areolata areolata* (Europe to Cape Verde), *D. areolata albolineata* (Ghana to Angola), and *D. areolata nigrolineata* (Caribbean). My objective in this project was to determine if the morphological subspecies scheme proposed in 1997 is supported by molecular data. Caribbean populations were not included in this analysis due to a lack of specimens preserved in ethanol and the rarity of the subspecies in the field. In addition, I included specimens of *Doriopsilla miniata* from South Africa, as I suspect it might be analogous to *D. areolata* based on morphological similarities. My data do not support the proposed subspecies scheme and indicate that *D. areolata* and *D. miniata* from South Africa are indeed synonymous. In the future, I would like to include further specimens from the full range of *D. miniata* to determine whether all of *D. miniata* should be synonymized with *D. areolata*.

DIVERSIFICATION OF FILTER-FEEDING NUDIBRANCHS: TWO REMARKABLE NEW SPECIES OF *MELIBE* (OPISTHOBRANCHIA: TETHYIIDAE) FROM THE TROPICAL WESTERN PACIFIC

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Two new species of the genus *Melibe* are described from the tropical western Pacific. *Melibe* sp. 1 is from northeastern Borneo, Malaysia. This species is transparent with a series of white interconnecting digestive gland ducts visible throughout the body. It is also characterized by having weakly denticulate jaws, highly ramified digestive gland tracks that extend throughout the body, and a reproductive system with an external nodular vaginal gland and a penis with a curved apex. *Melibe* sp. 2 is from the Philippines and Malaysia, has a deep golden brown color. The body is wide and densely covered with tubercles that form a mid-dorsal crest and cover the surface of the "cerata." Internally, this species has a massive muscular buccal mass, jaws with a finely denticulate margin, tuberculate ganglia in the central nervous system and an expanded, rounded receptaculum seminis. *Melibe* sp. 2 is associated with the scleractinean coral *Porites* sp. and the blue coral *Heliopora coerulea* although the nature of this association remains unknown. This species is also unusual in that the egg mass is carried on the right side of the body located posterior to the genital atrium and is found between the mantle and the foot. A morphological phylogeny suggests that *M.* sp. 1 is most closely related to *M. engeli* Risbec, 1937, *M. digitata* Gosliner & Smith, 2003 and *M. tuberculata* Gosliner & Smith, 2003. *Melibe* sp. 2 is a member of the Indo-Pacific clade of *Melibe* species, but its relationship to other taxa remains unresolved. Preliminary molecular data suggest a more complex relationship between *Melibe* species, but strongly support the notion that all of the species examined represent distinct lineages. The sister-group relationship of *Tethys* with *Melibe* is confirmed and the molecular phylogeny supports the monophyly of *Melibe* and Tethyiidae based on the combined molecular dataset.

FAMILY MATTERS: THE FIRST MOLECULAR PHYLOGENY OF ONCHIDORIDIDAE (MOLLUSCA: GASTROPODA: NUDIBRANCHIA)

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Recent investigations into the evolution of Onchidorididae using morphology have resulted in low support for relationships among genera. This study aims to determine if molecular analysis corroborates recent morphological interpretations of Onchidorididae. Five genetic markers (16S, 18S, 28S, cytochrome c oxidase 1 (COI) and histone 3 (H3)) were sequenced from 31 species comprising Onchidorididae and five other families; three from Anadoridoidea and two from Eudoridoidea. The total aligned length equaled 4059 bp, which consisted of 849 informative characters. Phylogenies were estimated using parsimony, maximum likelihood, and Bayesian inference analyses, which yielded similar topologies. The high quantity

and variability of molecular data analyzed resulted in high support for bootstrap and posterior probability values for the monophyly of the suctorian clade and the placement of the genera within Onchidoridídae. The historical members of Onchidoridídae do not constitute a monophyletic group. Molecular analyses also support previous hypothesizes regarding the unification of *Adalaria* and *Onchidoris*, as well as supporting the hemispheric separation within *Acanthodoris*, while also contradicting the placement of *Corambe* as the most derived member of Onchidoridídae. The circumboreal range of *A. pilosa* to include the Northeastern Pacific has also been refuted due to the rediscovery and previous misidentification of *A. atrogriseata*.

POPULATION GENETICS OF *HAMINOEA* (*HALOA*) *JAPONICA* PILSBRY, 1895, A WIDESPREAD NON-INDIGENOUS SEA SLUG (MOLLUSCA: OPISTHOBRANCHIA) IN NORTH AMERICA AND EUROPE

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Haminoea japonica is an opisthobranch mollusk with a large non-indigenous range. This species is a vector for a parasite that causes the human skin disease cercarial dermatitis, and may have negative effects on populations of native species. Molecular evidence from the mitochondrial cytochrome c oxidase I gene and the histone 3 nuclear gene indicates that previously published morphology-based hypotheses on the spread of *H. japonica* out of Japan are correct. The most likely explanation for the current range of the species, which includes Japan, Korea, France, Spain, Italy, Canada and the USA is a recent, human-mediated dispersal from Japanese populations. The highest levels of nucleotide and haplotype diversity are found in Japan. Non-indigenous populations have low levels of genetic diversity (indicating bottlenecking). Haplotypes that were detected in the non-indigenous range of *H. japonica* have only been found in two localities in the native range; these two localities are in northeastern Japan. In addition, the haplotype network structure and spatial analysis of molecular variance (SAMOVA) results confirm the non-indigenous populations most likely originated in northeastern Japan, which is where most Pacific oyster exports to North America also originated. Because there are no major shipping ports in northeastern Japan, ballast water is less likely to be the mechanism of dispersal. The results of this study provide important data for the development of policies and regulations aimed to prevent further spread of this species in non-indigenous ranges.

TRADITIONAL TAXONOMIC GROUPINGS MASK EVOLUTIONARY HISTORY: A MOLECULAR PHYLOGENY AND NEW CLASSIFICATION OF THE CHROMODORID NUDIBRANCHS

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Chromodorid nudibranchs (16 genera, 300+ species) are beautiful, brightly colored sea slugs found primarily in tropical coral reef habitats and subtropical coastal waters. The chromodorids are the most speciose family of opisthobranchs and one of the most diverse heterobranch clades. Chromodorids have the potential to be a model group with which to study diversification, color pattern evolution, are important source organisms in natural products chemistry and represent a stunning and widely compelling example of marine biodiversity. Here, we present the most complete molecular phylogeny of the chromodorid nudibranchs to date, with a broad sample of 244 specimens (142 new), representing 157 (106 new) chromodorid species, four actinocylcid species and four additional dorid species utilizing two mitochondrial markers (16s and COI). We confirmed the monophyly of the Chromodorididae and its sister group relationship with the Actinocyclidae. We were also able, for the first time, to test generic monophyly by including more than one member of all 14 of the non-monotypic chromodorid genera. Every one of these 14 traditional chromodorid genera are either non-monophyletic, or render another genus paraphyletic. Additionally, both the monotypic genera *Verconia* and *Diversidoris* are nested within clades. Based on data shown here, there are three individual species and five clades limited to the eastern Pacific and Atlantic Oceans (or just one of these ocean regions), while the majority of chromodorid clades and species are strictly Indo-Pacific in distribution. We present a new classification of the chromodorid nudibranchs. We use molecular data to untangle evolutionary relationships and retain a historical connection to traditional systematics by using generic names attached to type species as clade names. We will discuss why proposing new classifications is critical for demonstrating taxonomy's relevance and providing appropriate frameworks for all comparative studies in evolutionary biology.

SYSTEMATICS OF *GYMNODORIS*: INVESTIGATING A GENUS OF PREDATORS, CANNIBALS AND A PARASITE

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Gymnodoris is a unique genus of dorid nudibranchs consisting mostly of opisthobranch predators, including cannibals and a species that feeds on the fins of goby fishes. Originally established by Stimpson in 1855, the genus today contains approximately 35 described species distributed throughout the Indo-West Pacific. Many of these are older descriptions with insufficient details to associate names to living species, and overall, the group is in need of review and synthesis. Preliminary sampling indicates that *Gymnodoris* is a diverse, previously taxonomically neglected group with tens of undescribed species. Based on the molecular mitochondrial markers 16S, cytochrome oxidase subunit (COI) and the nuclear marker histone 3

(H3), we present evidence for cryptic diversity within some well known, widely distributed taxa. Ultimately, a phylogeny of *Gymnodoris* will bring more attention to this previously neglected clade of nudibranchs and serve to help us understand the evolution of the specialization of feeding in this group.

ECOLOGY AND NUTRIENT EXCRETION RATES OF A LARGE, NATIVE UNIONID MUSSEL, *ANODONTA*, COEXISTING WITH INVASIVE *CORBICULA* CLAMS, IN A SAN FRANCISCO RESERVOIR

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Freshwater mussels often are considered ecosystem engineers, and, at high densities, can influence lake ecosystem processes. Mussels filter phytoplankton, bacteria, and other particulate organic matter from the water column, and excrete nutrients in the form of urine and feces, which contain ammonium and phosphorous compounds, often nutrients that limit primary productivity in lakes. Large (7-9 cm long), native, freshwater *Anodonta* mussels (apparently belonging to the *californiensis/nuttalliana* clade) can be found in relatively high densities, coexisting with invasive clams (*Corbicula fluminea*), among dense invasive aquatic plants (*Myriophyllum spicatum*), in a drinking water reservoir that is closed to the public. Although many nutrient cycling experiments have focused on invasive species, fewer studies have focused on effects of native mussels on water quality. Unionid mussels are being extirpated from much of their range in Western North America and in many cases their impacts on aquatic ecosystems have not been adequately assessed.

Native *Anodonta* mussels were collected from San Andreas Reservoir (south of San Francisco, California) and brought to a temperature-controlled environmental chamber, scrubbed free of biofilms, and placed in deionized water. Water samples were collected at time steps over a period of five days and analyzed for ammonium, orthophosphate, and total phosphorus. Present data, for spring conditions, indicate that at 12°C, larger (~ 8 cm) individual *Anodonta* mussels excrete ammonium at a rate of ~5 µg NH3 / g (shell-free dry weight) / hour, orthophosphate at a rate over ~2 µg PO4 / g (shell-free dry weight) / hour, and total phosphorus at a rate over ~1 µg TP / g (shell-free dry weight) / hour. These nutrient excretion rates are similar to other unionid mussels such as *Lampsilis radiata siliquoidea* in the eastern United States.

A FOUR-GENE MOLECULAR PHYLOGENY OF THE SACOGLOSSA REVEALS RAMPANT POLYPHYLY AT GENERIC AND FAMILY LEVELS, AND AN OVERLY CONSERVATIVE TAXONOMY AT THE SPECIES LEVEL

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Recent interest has focused on sea slugs in clade Sacoglossa as models for the study of plastid symbiosis, ecological speciation, herbivore-host interactions, and transitions in larval

development. Some "species" are also of significance for biological control and drug discovery. However, work on these specialized consumers is complicated by taxonomic uncertainty at the species level, and the lack of a robust phylogenetic framework within which trait evolution can be modeled. We present a molecular phylogeny of 200 sacoglossan species using four gene regions (two mitochondrial and two nuclear loci) comprising 3 kb of sequence data. Within the shelled Oxynoacea, traditional genera and families are well supported but *Cylindrobulla* is resolved as a sacoglossan, sister to the Volvatellidae. Superfamily Limapontiodea, containing the ceratiform genera, is paraphyletic with respect to superfamily Plakobranchoidea. Polyphyly and paraphyly are rampant among limapontiodean genera, including *Placida*, *Ercolania*, *Stiliger*, *Limapontia*, *Cyerce*, and *Gascoignella*, highlighting the need for systematic revision. Two genera (*Cyerce* and *Costasiella*) do not belong to any currently recognized family, and family Platyhedylidae is not plakobranchoidean. Our analysis indicates that cerata were independently reduced or lost six times, and became enlarged and flattened twice; thus parallel evolution continues to confound the taxonomy of marine heterobranchs. Cryptic species complexes are also rampant in key groups studied for kleptoplasty, drug discovery and biological control, and fully one-third of our ingroup comprises undescribed species, emphasizing the need for focused efforts to catalog and delineate the true extent of sacoglossan biodiversity.

SLUGGING, POLE TO POLE

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Kevin Lee is an avid adventurer and underwater photographer who has traveled all over the world, including both polar regions where water temperatures are below freezing, in search of his favorite subject, opisthobranchs. Kevin took us on a photographic journey to remote waters and shared his findings of unusual and rare sea slugs.

NEW DATA ABOUT THE SALIVARY GLANDS OF CARNIVOROUS AND HERBIVOROUS CEPHALASPIDEANS (EUOPISTHOBRANCHIA)

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The clade Cephalaspidea is the largest within the Euopisthobranchia, comprising more than 800 species of marine slugs and bubble snails. The cephalaspideans include both herbivores and carnivores, but herbivory have been considered the plesiomorphic condition (1, 2). Switching from herbivory to carnivory must have required some modifications of the digestive system that are not yet clearly understood. For most species just gross anatomy data are available, but to understand the evolution of the digestive system of cephalaspideans more detailed information must be obtained from different families. For this study, the salivary glands of two herbivorous species, *Bulla striata* (Bullidae) and *Haminoea navicula* (Haminoeidae), and three carnivorous species, *Philinopsis depicta*, *Aglaja tricolorata* (Aglajidae) and *Philine aperta*

(Philinidae), were processed for light and electron microscopy. The two herbivores possess long ribbon-shaped salivary glands, extending from the back of the buccal mass to the posterior end of the anterior esophagus. Conversely, in the three carnivores the salivary glands are short and its posterior end is not attached to the outer surface of the digestive tube. Additionally, the salivary glands of these species are histologically distinct. The salivary glands of *B. striata* contain two types of mucous cells, named granular mucocytes and vacuolated mucocytes. In granular mucocytes, proteins are concentrated in electron-dense masses occupying about 26% of secretory vesicles volume and the remaining 74% contain acid polysaccharides. Granular mucocytes are also the main cell type in the salivary glands of *H. navicula*, but in this case the secretory vesicles are filled with filaments. Protein secreting granular cells and vacuolated mucocytes are minor components of the salivary glands in *H. navicula*. In *P. aperta*, protein secreting granular cells are larger and more abundant, but mucocytes still predominate in the salivary glands. In the two aglajids, secretory cells of the salivary glands belong to the seromucous type, containing a large amount of proteins associated with acid polysaccharides in electron-dense secretory vesicles. According to our observations, short salivary glands seem to be typical of carnivorous cephalaspideans, and in herbivores the secretion shows a trend to be richer in acid polysaccharides. Further studies are required to test this hypothesis.

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PHYLOGENETIC PLACEMENT OF THE ENIGMATIC OPISTHOBRANCH GENERA *DORIDOXA* AND *BATHYDORIS* WITHIN NUDIBRANCHIA

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The opisthobranch genera *Doridoxa* and *Bathydoris* have in the past been placed at varying positions among the nudibranch phylogeny. Odhner placed *Doridoxa* and *Bathydoris* as sister to each other within a group called Gnathodoridacea, sister to the dorids. Tardy placed *Bathydoris* as sister to the dorids within a group called Euctenidiacea, and placed *Doridoxa* as sister to Euctenidiacea. Schrödl, Wägele and Willan placed *Doridoxa* as sister to the cladobranchs. All these hypotheses were based on morphological characters alone, due in part to the unavailability of DNA sequencing technology (at least for older studies) and to a lack of readily available specimens from either group. Both *Doridoxa* and *Bathydoris* include deep-water species, most of which have only been found in Arctic or Antarctic waters. Of the specimens that are available, many were preserved in formalin, which makes them difficult to utilize for molecular work. For the present study I had access to representative specimens that were preserved in ethanol (*Doridoxa ingolfiana*, collected off the coast of Newfoundland, Canada, and *Bathydoris aioca*, collected off the coast of California) which have thus far yielded clean, usable mitochondrial gene sequences (CO1 and 16S). Nuclear gene sequences (H3 and 18S) will be obtained for this project as well. The goal of this study is to resolve the long-standing controversy surrounding the phylogenetic placement of these groups via the use of molecular techniques. Preliminary results will be presented based on mitochondrial sequences

obtained thus far. The results of this work will be the first evidence supporting the phylogenetic placement of these groups based on molecular data.

PEARL OYSTERS (*PINCTADA*) OF MIDWAY ATOLL (NORTHWESTERN HAWAIIAN ARCHIPELAGO)

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Pearl oysters (*Pinctada* spp.) may be an important component of coral reef ecosystems due to their community interactions, water filtering capacity, and potential for bioremediating nutrient and heavy metal pollution. Two species, *P. margaritifera* and the smaller *P. radiata*, have been reported previously from the Hawaiian Archipelago. Adult *P. margaritifera* are extremely rare at Midway Atoll, with only 13 located in 6 years of extensive bivalve surveys and other field-work. Genetic analyses, using the nuclear ITS1 and mitochondrial COI markers, have identified most 2010 and 2011 *Pinctada* recruits on Midway Atoll as a third species, *P. maculata*, previously undocumented from the Hawaiian Archipelago. A population matrix model for the genus *Pinctada* has been developed and parameterized using field measurements of recruitment, survival, and growth of *P. maculata* on Midway Atoll, survival and growth of adult *P. margaritifera* on Midway Atoll, and published data on distributions, abundances and size-distributions of *Pinctada* species from other locations. This model is used to project population sizes and dynamics of both *P. margaritifera* and *P. maculata* for several Hawaiian localities and to explore the impacts of possible management options.

A LARGE COMPLEX OF SPECIES OR PHENOTYPIC PLASTICITY? A MORPHOMETRIC COMPARISON OF THE GENUS *SPONDYLUS* IN NORTHWEST MÉXICO / ¿UN COMPLEJO DE ESPECIES O ELEVADA PLASTICIDAD FENOTÍPICA? UNA COMPARACIÓN MORFOMÉTRICA DEL GÉNERO *SPONDYLUS* EN EL NOROESTE DE MÉXICO

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Although the genus *Spondylus* has played an important economic, political, and cultural role, the taxonomy of this group has been particularly controversial. In México, there are three valid species: *Spondylus calcifer* Carpenter 1857, *S. princeps* Broderip 1833 and *S. leucacanthus* Broderip 1833, but the intraspecific, interspecific variation and overlapped characters used for identification even raise doubts about the robustness of the number of recognized species. In this sense the use of geometric morphometrics has allowed quantifications of the differences in body shape that can occur as a result of biological processes such as diseases, ontogenetic development, local adaptation to geographical factors, or differences due to evolutionary processes. These variations are difficult to distinguish, so geometric morphometrics can graphically display interspecific and interpopulation changes. This research analyzes the degree of morphometric

differentiation of the nominal species of the genus *Spondylus* distributed in northwestern México, in order to review their taxonomic status and provide input for proper management. An image of the inside of the left valve and configurations of 51 anatomical points of "x-y" coordinates were obtained from each individual; then they were standardized to eliminate the effect of the scale position, and rotation using the method of super-imposition. Procrustes and eigenanálisis; multivariate analyzes were performed. The results obtained from the canonical variables analysis statistically supported the existence of three groups. The percentage of correct assignment obtained from the quadratic distance of Mahalanobis indicated a high value (100%) of correct assignment suggesting the presence of three morphotypes statistically supported. Thus the revision of the morphological variation found in the shell supports the existence of three valid species and detects the existence of a possible taxonomic characteristic useful for discerning between the two species. Analyses based on molecular markers such as mtDNA (16S, COI) and Microsatellite loci are being conducted to support this study.

Aun cuando el género Spondylus *ha jugado un papel económico, político y cultural importante, la taxonomía de este grupo ha sido particularmente controversial. En México se distribuyen tres especies válidas:* Spondylus calcifer *Carpenter 1857,* S. princeps *Broderip 1833 y* S. leucacanthus *Broderip 1833; sin embargo las variaciones intraespecíficas, interespecíficas y el traslape de caracteres empleados para su identificación aun plantean dudas respecto a la robustez del número de especies reconocidas. En este sentido el empleo de la morfometría geométrica ha permitido cuantificar las diferencias en la forma del cuerpo que pueden ocurrir como resultado de procesos biológicos tales como enfermedades, desarrollo ontogenético, adaptación a factores geográficos locales, o divergencias debido a procesos evolutivos. Estas variaciones son difíciles de distinguir, por lo que la morfometría geométrica permite visualizar gráficamente los cambios interespecíficos e interpoblacionales. En el presente trabajo se analiza el grado de diferenciación morfométrica de las especies nominales del género* Spondylus *distribuidas en el noroeste de México, con el fin de revisar su estatus taxonómico y aportar resultados para su adecuado manejo. De cada individuo recolectado se obtuvo una imagen de la cara interna de la valva izquierda y se obtuvieron configuraciones de 51 puntos anatómicos de coordenadas "x-y", las cuales fueron estandarizadas para eliminar el efecto de la escala, posición y rotación mediante el método de super-imposición de Procrustes generalizado y eigenanálisis, se realizaron análisis multifactoriales. Los resultados obtenidos del análisis de Variables Canónicas soportó estadísticamente la existencia de tres grupos. El porcentaje de asignación correcta obtenido a partir de la distancia cuadrática de Mahalanobis indicó un alto valor (100%) de asignación correcta lo que sugiere la presencia de tres morfotipos estadísticamente soportados. De esta manera la revisión de la variación morfológica encontrada en la valva soporta la existencia de las tres especies válidas y detecta la existencia de un posible carácter taxonómico útil para discernir entre una y otra especie. Análisis basados en marcadores moleculares tales como ADNmt (16S, COI) y loci Microsatélites están siendo realizados con la intención de soportar este estudio.*

THE CONTRIBUTIONS OF CHARLES H. O'DONOGHUE TO OPISTHOBRANCH RESEARCH

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Charles H. O'Donoghue published papers on opisthobranch mollusks between 1921 and 1940. In his early years he published on species that he collected or were given to him, from the northeastern Pacific. He was interested in anatomical descriptions and equally interested in sorting out taxonomic discrepancies. Many papers were entirely or partly devoted to his attempts to regularize and prioritize names in current usage. His later work described specimens sent to him from scientific expeditions to various regions of the Indo-Pacific. We know of him from his opisthobranch research, but he was a well-rounded scientist, who was considered an expert in several fields.

A DIACHRONIC PERSPECTIVE ON THE LOCALIZATION OF DEFENSIVE METABOLITES IN CHROMODORID NUDIBRANCHS

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Opisthobranch gastropods provide some of the most remarkable, and best documented, examples of the evolution of chemical defense (1). In chromodorid nudibranchs a general trend is apparent towards the concentration of protective metabolites in exposed parts of the body in structures called repugnatorial glands or mantle dermal formations, which have evolved as mechanisms for concentrating and storing metabolites until releasing them at the appropriate time. In spite of this, it has been suggested that the defensive function of these glands is only secondary and that they evolved primarily for another function such as avoiding autotoxicity. There has even been proposed a scenario in which the repugnatorial glands in effect originated as a sort of kidney and only later evolved into a defensive mechanism. These scenarios are based on the assumption that the localization of defensive compounds is not essential for defense, an assumption inferred from investigations occurring at one point in time, giving negative results. Therefore, leaving aside the problems of interpreting negative results, these ideas do not really consider historical processes in denying the primary defensive role of the mantle glands. There is also a logical dilemma to be taken into account: if the problem for the nudibranchs were simply to avoid getting poisoned, what would be the selective advantage of selectively feeding on toxic prey items?

Here we consider other empirical evidence that is germane to such issues, but by also including an historical/evolutionary time dimension in the discussion, to propose the most plausible diachronic scenario, capable of explaining whether, over a long series of generations, localization has been favored by natural selection. According to the "pre-adaptive" scenario first suggested by Faulkner and Ghiselin (2), a shelled ancestor took to feeding upon chemically defended prey organisms, incidentally becoming repugnant to predators. This innovation set the stage for the elaboration of chemical defense and the reduction of the shell. It was the basis for an adaptive radiation, in which the various lineages have diversified both their diets and their utilization of defensive metabolites. On the other side, with the regression of the external shell and its role in

mechanical defense, the primitive function of the mantle of producing the shell has been lost. This has led to a reduction in the size of the mantle within the Chromodorididae, with the evolutionary conservation of easily accessible mantle edges and projections, where extremely high doses of distasteful compounds are actually localized (3). The observation that these parts are frequently damaged implies that the attention of predators has been directed to a distasteful part of the body, thereby reducing the amount of damage to the slug. The compounds are then accurately targeted into the predator's mouth as an extreme defensive measure against particularly determined and harmful attacks. To paraphrase Paracelsus, a localized high dose of distasteful compounds makes for a strong chemical defense. As a result of a long evolutionary process that has progressively led to the accumulation of defensive chemical weapons in localized anatomical structures, the extant chromodorid nudibranchs remain in place when molested, retracting rhinophores and gills, and deploy the distasteful sacrificial parts of the mantle against the predators.

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DISTRIBUTION AND ABUNDANCE OF HOLOPLANKTONIC MOLLUSKS FROM THE GULF OF TEHUANTEPEC DURING JULY 2007

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The Gulf of Tehuantepec is one of the most productive ecosystems within the eastern tropical Pacific. It has very high diversity due to the oceanographic and meteorological processes that influence the dynamics of the Gulf and establish the ecological conditions in the area. Because of the access difficulties that occur in the area, few studies have been conducted in order to describe marine communities in general. Studies have been focused mainly on species of commercial interest. Holoplanktonic mollusk communities are totally unknown for the Gulf of Tehuantepec, and thus, it represents an important area to get to know the species that inhabit the zone and the environmental parameters that limit their distribution and abundance. According to this, a study was performed in order to determine the species composition and the relationships between the distribution and abundance of holoplanktonic mollusks (Prosobranchia: Pterotracheoidea; Opisthobranchiata: Thecosomata and Gymnosomata) with environmental variables. Samples were taken during July 2007 using oblique tows with bongo nets. Samples belonging to the 333µm mesh net were analyzed, finding 40 species from which only nine contributed to 85% of all organisms. The canonical correspondence analysis (CCA) showed that the highest abundance was associated to a deeper mixed layer. Physical data suggest sinking of the mixed layer as a result of an anticyclonic eddy that is also consistent with the distribution of

surface chlorophyll shown by satellite images and the estimated geostrophic flow. Cluster analysis reflects that stations from the eastern part of the Gulf aggregate and separate from those on the western portion that are associated with the eddy. It also shows similarity greater than 65% between stations associated to the central part of the anticyclonic structure, which implies transport and concentration of organisms to the center. The exception was *Creseis chiarchiae* that was mainly distributed in the eastern coast of the Gulf, greatly associated to chlorophyll that shows a response to typical coastal upwelling and to terrestrial nutrient input.

UPDATE ON THE TERRESTRIAL MOLLUSKS OF CHIAPAS, MÉXICO

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In 1957 Bequaert summarized the knowledge of the non-marine mollusks of Chiapas. Thompson, in various papers, made several additions (1966, 1967, 1976), particularly describing species new to science. Later, Naranjo-García, Polaco and Pearse (2000) and Naranjo-García (2003) described two new species. Naranjo-García in 1993 noticed that the land mollusks of Chiapas differ from other Pacific states of México, and have a closer relationship with the land mollusks of Guatemala. Samples from various sites of Chiapas in the National Collection of Mollusks (Colección Nacional de Moluscos) were studied in order to prepare this work. Shells were soaked in a weak solution of photo floo®, briefly cleaned with a brush or in an ultrasound cleaner and thoroughly rinsed after either treatment before being allowed to dry on paper towels. At the time of identification, the species were separated. Total records for the state of Chiapas yielded the figures of 22 families and 112 species; about 9.3% of the known fauna of the country. Twenty-nine species have been recorded in a single locality (26% of the fauna of the state). Their present status is unknown: i.e. if they are endemic or not, if they are still extant, or if they are in danger of extinction. These are issues to be resolved. The best well recognized species are *Lysinoe ghiesbreghti* (which is distributed in Chiapas and Guatemala) and *Helicina tenuis*, occurring from Jalisco to Guanajuato states to southeastern México. *Orthalicus princeps* is widely distributed along the Gulf of México, and from Guatemala, Belize, Honduras, and El Salvador to Costa Rica. Among the micromollusks *Lucidella lirata* is the most frequently found snail at the Montes Azules Biosphere Reserve. Cecilioides is a new record from the same area. Changes in the use of the land may modify the view we have of the terrestrial mollusks of Chiapas state.

A TALE FROM A HYPERDIVERSE GROUP OF CEPHALASPIDEAN GASTROPODS IN SCANDINAVIA: THE FAMILY PHILINIDAE

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Worldwide knowledge about the diversity of philinid gastropods is broadly hampered by lack of sound descriptions of species. The Scandinavian Peninsula is no different and most taxonomic work has focused on the description of species based on the external form and sculpture of shells, which led to taxonomic confusion and uncertainty on the number of valid taxa. Recent accounts on Scandinavian Cephalaspidea referred to 13–15 species of Philinidae ascribed to four genera.

Here we present the results of a recent systematic revision based on an integrative approach combining shells, morpho-anatomical characters, and molecular phylogenetics. Seventeen species have been identified and a total of 52 nominal names recognized. Phylogenetic evidence did not support generic division of Philinidae species, thus, all species were ascribed to the genus *Philine*. Five of the 17 species identified are new to science and 10 were barcoded (partial sequences of the mitochondrial COI gene).

Philinidae alone accounts for nearly half (ca. 45%) of cephalaspidean diversity in Scandinavia, where seven families are recognized with a total diversity estimate of 38 species.

OPISTHOBRANCHS OF MÉXICO, WHAT WE DON'T KNOW

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Opisthobranch literature for the Pacific Coast of México is richer than that from the Atlantic coast of México, where the fauna has been little studied until 2003. Based on a bibliographic research of articles, books, and theses in Mexican universities (most of them focused exclusively on this group of gastropods), I obtained a list of more than 400 species of opisthobranchs for the Pacific and Atlantic coasts of México. This list includes species for almost all opisthobranch groups, with the exception of the Acochlidiacea. This review includes undescribed species recorded in studies with photographs, so I could compare them with species that have been described after their illustration so I did not duplicate taxa on the list. The Pacific coast of México has the highest percentage of species, especially the Gulf of California, which is one of the most diverse areas in western México. The Atlantic coast of México has 25% of the recorded species (including Gulf of México and Caribbean Sea), and the rest are recorded from both coasts. This is the first attempt to group together all opisthobranch records in the country. At this point this review clarifies the gaps in data for some Mexican states. Nevertheless it is premature to produce the inventory of the sea slugs that inhabit Mexican waters.

A COLORFUL QUESTION: THE CHROMODORIDID *FELIMIDA CLENCHI* SPECIES COMPLEX INVESTIGATED THROUGH COI

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The body color pattern is commonly utilized in the taxonomy of nudibranchs. For some species, body color varies according to the color of their prey. Groups of species with similar color patterns also occur, but having no direct relation to their food, indeed reflecting a common origin or convergence events. Among the Chromodorididae, species color groups are usual and result in doubts concerning the number of species involved, also due to similarities in internal morphology. In the tropical Atlantic and Mediterranean Sea, the *Felimida clenchi* species complex (formerly *Chromodoris clenchi* complex) includes three western Atlantic species names: *Felimida clenchi* (Russell, 1935), *Felimida binza* (Marcus & Marcus, 1963) and *Felimida neona* (Marcus, 1955), and an eastern Atlantic/Mediterranean species name: *Felimida britoi* (Ortea & Pérez, 1983). The validity of these species and their geographic distribution was repeatedly a matter of debate along the years. Using multi-locus markers for tree-based and other approaches, in complement to morphology and field observations, we aim to identify the main lineages of this group and their relationships, based on specimens covering most of the complex geographic range. Our preliminary results based on mitochondrial COI analysis indicate the monophyly of the *Felimida clenchi* complex. However, the traditional species concepts in this complex were not recovered in most cases, as morphotypes assigned to different species clustered together and color forms attributed to a single species are distributed in separate clades. Our results will be tested by adding further nuclear markers, cross-checked with anatomy and correlated to original species descriptions and available type-material, in order to establish the correct names, geographic ranges and evolutionary history for the different species identified.

ARE TEMPERATE LAND SNAILS SUSCEPTIBLE TO CLIMATE CHANGE THROUGH REDUCED RANGES UPWARD? A PENNSYLVANIA EXAMPLE

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Distributions of some plants and animals have already shifted in recent years due to climate warming, and climate warming has potential to cause extirpations of populations of taxa that cannot easily move or adapt. Slow-moving snails might be susceptible to climate warming

and indeed, the Aldabra banded snail (*Rhachistia aldabrae*) gained the distinction of being the first documented species to become extinct due to climate change. Climate warming has the potential to threaten land snails in a number of ways, as examples, slow-moving snails might not disperse fast enough to stay within their shifting habitats, climate warming might cause changes in moisture availability, and warming might facilitate increase or new populations of diseases, predators, and competitors in an area. In this study we focus on whether snail populations currently confined to cooler habitats at higher elevations might be reduced or eliminated if their ranges are reduced upward by climate warming.

A study in Pennsylvania, USA, examines whether some land snail species are limited to upper elevations to assess whether climate warming poses a threat to them. Sampling included 108 sites across Pennsylvania, comprising 12 replicates at elevations in 100m increments from 100 to 900m elev. Numbers of snail species, abundances, and Shannon diversity all decreased at greater elevations. Most individual species tended to occur throughout sampled elevations or occurred primarily at lower elevations, so the reduced-range-upward aspect of climate warming might not threaten them. However, some species occurred more at greater elevations, suggesting that their populations might decline if climate warming reduces their ranges upward.

CRYPTIC MOLLUSCS OF THE ROCKY INTERTIDAL ZONE IN VERACRUZ, MÉXICO

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This study evaluated the species richness and abundance of cryptic molluscs of rocky substrates in two locations in the southern region of the State of Veracruz, México: La Mancha and Montepio. The study was carried out during the year 2003-2004, by bimonthly sampling in the intertidal zone. The molluscs were donated for analysis to the Laboratorio de Malacología of the ICML, as part of a larger research project, with emphasis on crustaceans, by the staff of the Laboratorio de Carcinología of the Instituto de Biología of the UNAM. Rock samples were broken with a chisel and hammer to remove the associated fauna. A total of 3,637 specimens belonging to 36 species of molluscs were identified, of which 28 were gastropods and eight were bivalves. The highest species richness and abundance was recorded in La Mancha, with 31 species and 2,730 individuals. In that location, 74.2% of the species were gastropods and 88.6% of the individuals were bivalves. The dominant species, based on the abundance and frequency in the study area, was *Isognomon bicolor*, with 1,822 individuals in the two localities.

CLASS SCAPHOPODA IN MÉXICO

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For many years the class Scaphopoda has received little attention, however, with the work of Stainer Kabath and Scarabino, interest in this group has grown. In México, there is only

one publication specialized in Scaphopoda and it is restricted to the state of Jalisco. Therefore the group remains poorly studied in this country and even basic biology aspects must be investigated. The goal of this work is to analyze Mexican malacological collections as well as papers and databases from collections in the United States to develop a taxonomic key and an identification guide of the group for Mexican waters.

We have identified 10 species inhabiting the Atlantic Ocean with 52 specimens from five localities, while 34 species are present from the Pacific coast, with 59 specimens from seven localities.

At present, most of the Scaphopoda records belong to US databases, since Mexican collections contain materials that are eroded or partially broken. This work intends to establish a baseline for further studies of Scaphopoda, particularly in species distributed in Mexican waters.

THE *DOTO CORONATA* SPECIES COMPLEX

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A molecular phylogeny of the nudibranch family Dotidae has never been constructed. The genes 16S, H3, and COI were compared to establish a better understanding of the *Doto coronata* (Gmelin, 1791) species complex and ascertain the relationships within this ambiguous family. Since *D. coronata* is the type species for *Doto* (Oken, 1815), it is important to know which specimen/species within the complex actually represents the genus as a whole. The *Doto* within this species complex are difficult to distinguish since their morphologies are so similar. The original description of *D. coronata* was collected from a *Eudendrium* along the Dutch coast. Several specimens thought to be *D. coronata* were incorporated into the analysis. These included single specimens collected from Maine, U.S.A., the North Sea and South Africa; three from Wales, UK on the hydroids *Obelia dichotoma*, *O. geniculata,* and *Sertularia argentea;* and three specimens from Ferrol, Spain discovered on *Campanularia hincksii, Sertularella polyzonias,* and a *Halecium* sp. Individual and combined gene trees were formulated utilizing Maximum Likelihood and Bayesian analyses.

DNA INTEGRITY IN BIVALVES AS A BIOMARKER OF ENVIRONMENTAL CONDITIONS

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In this study a determination of the integrity of the DNA was carried out in the gill tissue of juvenile bivalve, from the coastal systems (Gulf of México and the Sea of Cortez), to detect the presence of genotoxic substances, and to evaluate the use of this biomarker as a reliable tool

for environmental biomonitoring studies. Samples of gill tissue were disintegrated; the degree of damage in the DNA was determined by means of the Single Cell Gel (SCG) Electrophoresis or Comet Assay technique. The proportion of cells with and without damage and the length of 100 cells per organism were evaluated. We analyzed between 15 and 10 specimens each in summer and winter for two years. The results of genetic integrity indicated that there are significant differences in the number of cells with damage and lesions. Organisms in the Gulf of México presented the highest number of damaged cells (90%) and the largest size in the caudas (120.5 mm), in comparison with those obtained in Ensenada de la Paz (31% and 91 mm). The previous results agree with the pollution levels registered in the place where the bivalves were collected, because of the high concentrations of heavy metals and PHA´s. It is evident that this biomarker is a good tool in environmental biomonitoring studies.

OXIDATIVE STRESS AS A TOOL TO ASSESS AQUATIC HEAVY METALS CONTAMINATION USING THE CATARINA SCALLOP *ARGOPECTEN VENTRICOSUS* (SOWERBY, 1842)

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The Catarina scallop is an important fishery resource in the state of Baja California Sur México, where 95% of national production is obtained. Since the 1970's, the fishery has declined up to 86%, apparently caused by over exploitation. Due to a lack of environmental studies related to any alternative cause, in this study an evaluation of two biomarkers, oxidative stress and genetic damage, were carried out in the gill tissue of Catarina scallops, at the nursery of UABCS, to detect the presence of toxic and genotoxic substances, and evaluating the use of these biomarkers as a reliable tool in environmental biomonitoring studies. Adult scallops (5.0 ± 0.5 cm) were collected in summer and winter during 1998, 1999 and 2000, in the culture facilities, located near the Pichilingue Harbor. The gill tissue samples were disintegrated; oxidative stress was determined as malondialdehide (MDA) concentrations. We analyzed between 15 and 20 specimens per seasons (summer and winter) each year. The results indicated that there are significant differences in the oxidative stress grade between the organisms collected in summer and winter. The organisms collected in summer (1998) presented the highest grade of lipid peroxidation (42.7 nM MDA) and the largest number of damaged cells (41%) and the size in the tails (90 ± 38 μm), in comparison with the ones obtained in winter (2000) (9.07 nM MDA) (14 % and 20 ± 6.1 μm). The previous results agree with the pollution levels registered in the place where the scallops were collected, because of the higher concentrations of heavy metals in summer. It is evident that this biomarker is a good tool in environmental biomonitoring studies.

EXTREME VARIATION QUESTIONS THE ECOLOGICAL AND EVOLUTIONARY ROLES OF COLOR PATTERN IN A SHALLOW WATER SPECIES OF OPISTHOBRANCH MOLLUSK

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It is widely accepted that color in benthic opisthobranch sea slugs (Mollusca: Gastropoda) plays an important defensive role and that numerous species have aposematic (warning) colorations. Color pattern is an important trait for opisthobranch identification – this is based on the assumption that many species have limited color variation. For those species in which color variation is recognized, the reasons for the variation remain unknown. In this paper we studied *Philinopsis pusa*, a putative benthic species of opisthobranch sea slug with a broad range of color pattern. Lighter individuals appear to be camouflaged on the white sand environment in which the animals are typically found, whereas darker individuals stand out. Because of its broad color variation *P. pusa* has been subdivided into different species.

Animals were collected and observed in the Bahamas during a 6-year span. The color pattern of the specimens was categorized into 5 phenotypic classes. Two mitochondrial genes (16S, CO1) were sequenced from 41 specimens. The association between color pattern, body length, burrowing escaping behavior, and the genetic structure of the population was investigated. We found two genetically distinct groups in the target population but no significant association between the color and genetic structure. Additionally, there is no significant association between color pattern and body length or burrowing time. These results question the ecological and evolutionary significance of color pattern in *P. pusa* and raise a word of caution on broad generations on the biological and evolutionary role of color in opisthobranchs and other marine organisms.

COMMUNITY STRUCTURE OF SOFT BOTTOM MOLLUSCS FROM CERRALVO ISLAND, GULF OF CALIFORNIA, MÉXICO / *ESTRUCTURA DE LA COMUNIDAD DE MOLUSCOS DE FONDOS BLANDOS DE LA ISLA CERRALVO, GOLFO DE CALIFORNIA, MÉXICO*

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The Gulf of California and its islands have a diverse scenic beauty making them one of the most attractive places in México with a great demand in tourism markets. Due to the lack of knowledge we have on the benthic community it is necessary to carry out management plans that lead to the formulation of strategies, conservation and development of these. The objective of this study was to determine the composition and community structure of sandy mollusks of Cerralvo Island and its relation to sediment type. We selected 32 sampling sites, from which were collected 64 samples, 32 corresponded to biological samples and 32 sediment, obtained by scuba diving. We analyzed the abundance and diversity of the benthic malacological community

as ecological indicators. There were 7,320 specimens of 145 species of mollusks, the best represented family was Tellinidae with the most abundant species *Tellina eburnea* (50.7%), followed in importance by *Transennella humilis* (9%), while the bivalve *Megapitaria squalida* was the species most widely distributed in the sites. The greatest richness was found in shallow bottoms of fine sand between 8 m deep. The average values obtained diversity index (2.28 bits / Single.) Have proven to be higher compared to other places in different latitudes of the west coast of the Gulf of California. The canonical correspondence analysis shows that the sediments are the main factor in the distribution of mollusks on the other environmental variables.

El Golfo de California y sus islas, poseen una belleza escénica y una diversidad inigualable a nivel mundial, convirtiéndolos en uno de los sitios más atractivos de México con una gran demanda en los mercados turísticos. Debido a la falta de conocimiento que se tiene sobre la comunidad béntica es necesario llevar a cabo planes de manejo que conlleven a la formulación de estrategias, conservación y desarrollo de estas. Por lo que el objetivo del presente estudio es conocer la composición y estructura de la comunidad de moluscos de fondos blandos de la isla Cerralvo y su relación con el tipo de sedimento. Se seleccionaron 32 sitios de muestreo en el cual se recolectaron 64 muestras, 32 correspondían a muestras biológicas y 32 a sedimento, obtenidas mediante buceo autónomo. Se analizó la abundancia y la diversidad de la comunidad béntica malacológica como indicadores ecológicos. Se contabilizaron 7,320 ejemplares pertenecientes 145 especies de moluscos, la familia mejor representada fue Tellinidae con la especie más abundante Tellina eburnea *(50.7 %), siguiéndole en importancia* Transennella humilis *(9 %), mientras que el bivalvo* Megapitaria squalida *fue la especie de mayor distribución en los sitios. La mayor riqueza específica fue encontrada en fondos someros de arenas finas entre los 8 m de profundidad. Los valores promedio del índice de diversidad obtenidos (2.28 bits/indiv.) han resultado ser mayores en comparación a otros sitios a diferente latitud del litoral occidental del Golfo de California. El análisis de correspondencias canónicas muestra que el tipo de sedimento es el factor principal en la distribución de los moluscos con respecto a las otras variables ambientales registradas.*

SYSTEMATICS AND PHYLOGENY OF *FAVORINUS*, A CLADE OF SPECIALIZED PREDATORY NUDIBRANCHS

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The genus *Favorinus* is a group of aeolid nudibranchs within the family Facelinidae. Members of this genus are ecologically distinct from other aeolid species in that they specialize in preying upon opisthobranch eggs rather than feeding on coelenterates. Because of this novel feeding habit, further study of *Favorinus* has been advocated to provide insight into possible reasons for the sequestration of nematocysts from coelenterate prey by aeolid nudibranchs (Edmunds, 2009). Previous accounts of the state of the common aeolid organ, the cnidosac that holds the stolen nematocysts, in *Favorinus* have been varied (Garcia and Troncoso 2001; Edmunds, 2009). Cerata from 13 species of *Favorinus* were analyzed in this study. The evolutionary history of the genus was examined by sequencing a 328bp fragment of the nuclear histone 3 gene (H3), a 658bp fragment of the mitochondrial protein-coding cytochrome *c* oxidase

subunit I gene (COI) and a ~430bp fragment of the mitochondrial large ribosomal subunit gene (16S) for 11 species of *Favorinus* and five outgroup taxa. A total of 1433 characters were used for parsimony, likelihood and Bayesian inference phylogenetic analyses. Similar topologies were produced by all analyses with the monophyly of described species of *Favorinus* being weakly supported by all. The majority of species of *Favorinus* possessed a cnidosac with the exception being the undescribed *Favorinus* sp. 4. The internal anatomy of the cerata of the most basal species of *Favorinus* deviated from those of the majority of the genus. In the most basal members, the digestive gland does not fill the entire ceras and is connected to the cnidosac by a thin channel. Nematocysts were present within the cnidosacs of all species analyzed, which suggests the importance of maintaining an active defensive function of nematocysts within the cnidosac.

ARE SIPHON LIMPETS BASAL PULMONATES OR STEM OPISTHOBRANCHS? USING COMBINED MOLECULAR DATA SETS TO RESOLVE DIFFICULT PHYLOGENIES

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The siphon limpets (Siphonariidae) are unusual "pulmonate" limpets not only in their marine habitat but also in having both a lung and a secondary "gill" used for respiration, at least in some species, so some siphonariids are regularly submerged underwater. The pulmonate phylogenetic affinities of Siphonariidae have recently been challenged. Conventionally, these have been considered basal pulmonates and a recent nuclear ribosomal DNA analysis supports this placement, but complete mitochondrial genome comparisons have instead placed them either as a sister taxon of Sacoglossa within opisthobranchs, or as unresolved within opisthobranchs. Other analyses have supported a Siphonariidae plus Sacoglossa clade as the most basal of several lineages that are paraphyletic to Eupulmonata, or have resolved opisthobranchs as paraphyletic to Pulmonata. Much of the conflict seems to be between data sets composed exclusively of mitochondrial genes and those featuring a large proportion of nuclear gene data. One hypothesis for the difficulty in establishing a positional consensus of the Siphonariidae is that the relatively rapidly evolving protein-coding mitochondrial genes, including the widely sequenced cytochrome oxidae I (COI) gene, are not only "noisy" for resolving deep nodes but have a systematic bias that conflicts with the phylogenetic signal. This hypothesis is tested here using both separate trees and combined dataset methods designed to isolate any potential conflicting phylogenetic signals.

SYSTEMATIC REVISION AND ANATOMICAL REVIEW OF *CHELIDONURA* SPECIES (CEPHALASPIDEA: GASTROPODA)

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Preliminary results of the Ph.D. project "Global diversification patterns in the Ocean: Molecular phylogeny of the family Aglajidae and systematic revision of the genus *Chelidonura*" are here presented. This project aims to shed light on the drivers of diversification of Atlantic and Indo-Pacific species of *Chelidonura*, to review the systematics of the genus, and to infer generic relationships within the family Aglajidae. *Chelidonura* is the most diverse genus of the family Aglajidae with 36 nominal names available of which 22 represents potential valid species. Four species are known in the western Atlantic, 3 in the eastern Atlantic and 15 in the Indo-West Pacific. The genus is noticeable absent in the eastern Pacific. During this talk a short presentation of the project, most relevant diagnostic morpho-anatomical characters, notes on the systematic historical changes as well as geographic distributions of species will be presented. This project is funded through a doctoral grant to the first author by the Consejo Nacional de Ciencia y Tecnología (CONACYT- México), fellowship BAZS/188890/2010.

EXTENDED ABSTRACTS

AN UNUSUAL MOLLUSCAN FAUNULE FROM THE UPPER PART OF THE MONTEREY FORMATION (MIDDLE TO LATE MIOCENE) IN ARROYO SECO, MONTEREY COUNTY, CENTRAL CALIFORNIA

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(other students were present but their parents did not give permission to use their names)

Abstract

A small fauna of at least 13 mollusks (11 bivalves, two gastropod) has been collected from a single site from the upper member of the Monterey Formation (Dibblee, 2006) along Arroyo Seco, Monterey County, central California. Fossils from this site are referred to the Arroyo Seco faunule and include the bivalves: *Katherinella oregonensis* Conrad (Veneridae), *Nuculana* aff. *N. furlong* (Trask) (Nuculanidae), *Pacipecten discus* (Conrad) (Pectinidae), an indeterminate Pandoridae(?), *Scapharca? obispoana perdisparis* (Wiedey) (Arcidae), *Tellina* cf. *T. argonia* Dall (Tellinidae), *Tellina congesta* (Conrad) (Tellinidae), indeterminate Tellinidae, at least two indeterminate Veneridae (based on shell outline), a possible Vesicomyidae, and the gastropods *Trochita* sp. (Calyptraeidae) and an indeterminate Naticidae. The families Pandoridae and Vesicomyidae (both questionably identified), have not been reported previously from deep-water sediments of the Monterey Formation.

The occurrence of the Pectinid *Pacipecten discus* restricts the age of the Arroyo Seco faunule to the "Margaritan" California provincial molluscan stage (CPMS; late middle to middle late Miocene). The upper member of Monterey Formation is reported to contain foraminifers of the Mohnian benthic foraminiferal stage (middle middle to middle late Miocene) and is overlain by the "Margaritan" CPMS age Santa Margarita Formation (formerly Pancho Rico Formation) close by in Reliz Canyon.

According to Patsy Smith (*in* Durham, 1970) the foraminiferal faunas from the underlying Sandholdt Member of the Monterey Formation typify bathyal (200-2000 m) water depths. While mollusks from the overlying Santa Margarita Formation represent inner to outer neritic water depths (0-150 m). Much of the mollusk fauna Arroyo Seco faunule indicates shallower inner to outer neritic water depths with the exception of the family Vesicomyidae (> 500 m). However, many of the bivalve mollusks are broken single valves indicating transport and upper bathyal water depths are not unreasonable when combined with other fauna elements and the sedimentology.

Introduction

This study was designed to introduce middle school children to invertebrate paleontology, to give them experience in collecting fossils, identifying them, and seeing though to publication a study involving the fossils they collected. Eight visits to the site each of several hours duration by up to a dozen people/visit (children, parents, student coordinator, family members, and myself) and other preliminary visits resulted in several hundred man-hours of

collecting and accumulated several hundred moderate- to well-preserved specimens that will be deposited at the California Academy of Sciences in San Francisco (CAS-IP) at the conclusion of this study.

The outcrop and fossil site is perhaps 20 m long and 10 m high and is located in a road cut (figure 1) on the north side of the road between 45078-45080 Arroyo Seco Road (County Road G16), west of Greenfield, Monterey County, central California (figure 2; latitude 36.2664°, longitude -121.3594°). About 2 m of section (dipping perpendicular to the road cut) is exposed and the rocks are mainly porcelanite referred to the upper member of the Monterey Formation (Dibblee, 2006). Porcelanite is a silica cemented rocks that is less hard, dense, and vitreous than chert and has a dull luster (Bramlette, 1946). Most of the fossils were collected along the west side of the outcrop where about a meter of section is exposed.

Figure 1.—View of the western edge of outcrop of the upper member of the Monterey Formation on the north side of Arroyo Seco Road (County Road G16), west of Greenfield, Monterey County, central California. Two students from C.T. English Middle School are present in the photograph.

Abbreviations used in the text include: CAS —California Academy of Sciences (San Francisco, Calif.); LACM — Los Angeles County Museum of Natural History (Los Angeles, Calif.); *s.s.* – *sensu stricto* (in the narrow sense); UCMP — Museum of Paleontology, University of California (Berkeley, Calif.); USNM – United States National Museum (Washington, D.C.); USGS – U.S. Geological Survey (Menlo Park, Calif.).

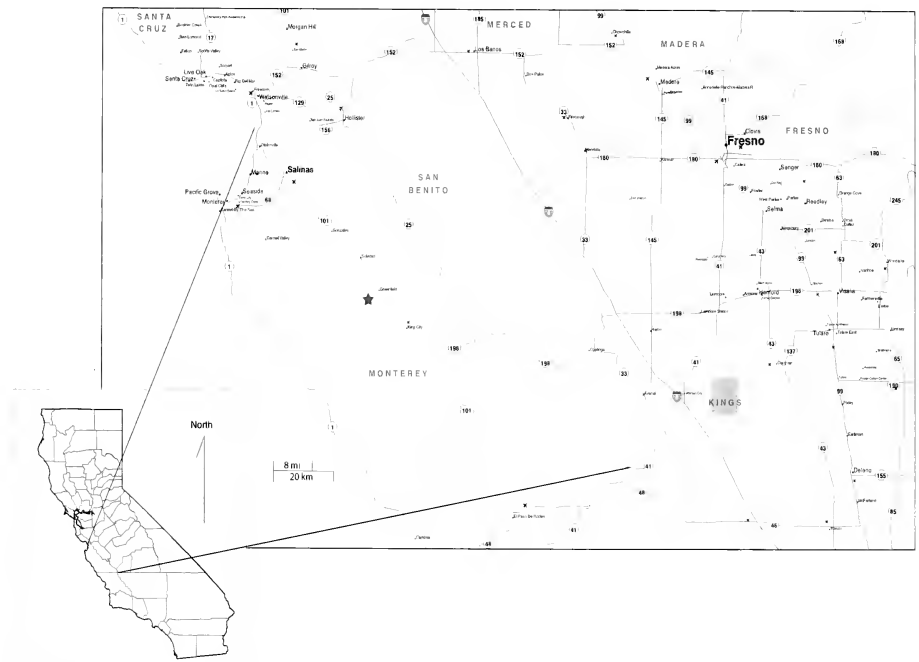

Figure 2.—Map of Monterey County showing approximately locality of fossil site (red star) along Arroyo Seco Road, west of Greenfield, Monterey County, central California (from http://bridgehunter.com/ca/monterey/big-map/).

Previous Work

Mollusks from biogenic sediments of the Monterey Formation at and near the type locality in Monterey County were previously reported by Lawson (1893), Martin (1912), Hanna (1928), and Powell (2001). A.C. Lawson (1893) is the first to report mollusks from rocks attributed to the Monterey Formation *s.s.* while mapping Carmelo Bay (= Carmel Bay), just south of the Monterey Peninsula. His fossils are all bivalve mollusks and were identified by W.H. Dall (1845-1927; USNM). They include an indeterminate Cardiidae or Carditidae (as a young *Cardium* or small *Venericardia*), *Clementia*? sp., *Delectopecten peckhami* (Gabb) (as *Pecten peckhami*), *Parvilucina?* aff. *P.? crenulata* Conrad (as "*Lucina*" aff. *L. crenulata* Conrad; *Parvilucina crenulata* is a Miocene to Pleistocene west Atlantic Ocean species), also an indeterminate *Macoma* (as *Macoma* sp. nov.?), an indeterminate *Nuculana* (as *Leda* n. sp.?), and *Scapharca? obispoana perdisparis* (Wiedey) (presumably as *Arca* n. sp.?). This introduction to the Monterey Formation molluscan fauna was followed by Martin (1912) who discussed the fauna from the type Monterey Formation and reports nine bivalves and three gastropods from unspecified lower, middle, and upper divisions of the Formation (Table 1).

Table 1. Fauna reported from the Monterey Formation by Martin (1912) in the vicinity of the type locality, Monterey, California.

MOLLUSCA	LOWER	MIDDLE	UPPER
BIVALVIA			
Cyclocardia montereyana (Arnold) [as *Venericardia montereyana* Arnold]	X	-	-
Delectopecten peckhami (Gabb) [as *Pecten packhami* Gabb]	X	-	-
Glycymeris sp.	X	-	-
Katherinella angustifrons (Conrad) [? as *M. oregonensis* Conrad]	-	X	X
Macoma congesta (Conrad)	X	X	X
Modiolns sp.	X	-	-
Nucula sp.	X	-	-
Nuculana cf. *N. taphria* (Dall) [as *Leda*, compare *taphira* Dall]	X	-	-
Scapharca? (Scapharca?) obispoana perdisparis (Wiedey) [as *Arca obispoana* Conrad]	X	X	-
GASTROPODA			
Ficus kernianum Cooper	X	-	-
Naticidae, indeterminate (as *Neverita* sp. indet.)	-	-	X
Trochita sp.	X	-	-

In 1928 G Dallas Hanna discussed the fauna and flora of the type Monterey Formation but added little with regards to the mollusks fauna. Powell (2001) reports a small fauna of five taxa from the diatomaceous part of the Monterey Formation in the nearby Spreckles 7.5' Quadrangle. This assemblage includes the inarticulate brachiopod *Discinisca* cf. *D. lamellosa* and the bivalve mollusks *Pacipecten discus*, a questionable *Delectopecten*, a specimen provisionally referred to the genus *Macoma*, and *Scapharca? obispoana perdisparis*. The occurrence of *P. discus* indicates the deposits are of "Margaritan" California provincial molluscan stage (CPMS) age or late middle to middle late Miocene. With the exception of the

questionable *Delectopecten* these taxa all also occur at our Arroyo Seco site.

Mega-invertebrates fossil have been reported elsewhere in California from rocks attributed to the "Monterey" Formation[1]. These include works on mollusks: Woodring and others (1936), Woodring and others (1946), Saul and Stadum (2005); arthropods: Rathbun (1932), Hof and Schram (1998), Buckeridge and Finger (2001); and annelid worms: Hedley (1991, 1992), Finger and others (2008). In addition, regional geologic studies in Monterey County that include mega-invertebrate fossil occurrences in their discussion are found in Bowen (1965) and Powell (2001), although parts of these discussions deal with arenaceous rocks referred to the Monterey Formation.

Fauna

Taxa found during the present study, their age, environmental significance, and other occurrences are noted below. Most of the larger bivalves collected are incomplete and have only comarginal growth lines as sculpture therefore their identification is a best guess based on shell outline. Still at least three or four, possibly more large bivalve taxa are distinguished from the material on hand.

MOLLUSCA: BIVALVIA

FAMILY ARCIDAE

About 30 moderately well-preserved specimens of *Scapharca? obispoana perdisparis* (Wiedey, 1928) (figures 7, 10) are present in our collections. The large size and thin shell makes it difficult to find complete specimens. They are much commoner in outcrop than the number collected would indicate. *Scapharca? obispoana perdisparis* is regarded as a subspecies of *S.? obispoana obispoana* (Conrad, 1857) agreeing in the number of ribs with the nominal species, but differs in being flatter and more elongate than the nominal form. However, no sharp lines can be drawn between the two subspecies (Reinhart, 1943). *Scapharca? obispoana perdisparis* has been reported only from the Monterey Formation in central California (Moore, 1983; Powell, 2001; 2007). The precise age of its type occurrence is not know, but the age of its occurrence in the Spreckles 7.5 quadrangle, Monterey County (Powell, 2001) and here is "Margaritan" CPMS.

FAMILY NUCULANIDAE

Several specimens from the Arroyo Seco locality have the same general outline and size and are compared with (aff.) the *Nuculana furlongi* (Trask, 1922) (figure 3-5) from the Briones Formation (middle Miocene) of central California (Weaver, 1953; Hall, 1958). Some Monterey Formation specimens are better preserved than the type specimen illustrated in Moore (1983, pl. 2, figs. 35, 36), but others are poorly preserved and still others are partially covered which does not allow for precise identification.

FAMILY PANDORIDAE

A single specimen is questionably referred to the family Pandoridae, (figure 14) based on its overall shape, which resembles several genera within the family, but distinguishing features

[1] The use of "Monterey" Formation in quotes designates that the rocks are not continuous with and (or) cannot be correlated lithologically to the type Monterey Formation. Rocks of the "Monterey" Formation are usually, but not always, of similar lithology and of similar age, but are removed from the type locality and, in many cases, should be assigned to new or different pre-existing lithostratigraphic units.

are not present. This family has not previously been reported from the Monterey Formation.

FAMILY PECTINIDAE

Nearly 50 moderately- to well-preserved specimens of Pectinid are attributed to *Pacipecten discus* (Conrad, 1857) (figures 6, 8) based on their size, shape, and rib count. *Pacipecten discus* has been reported from the Branch Canyon Sandstone (middle Miocene; Vedder, 1973), Briones Sandstone (middle Miocene; Trask, 1922; Weaver, 1953; Hall, 1958), Castaic Formation (late Miocene; Stanton, 1966), Cierbo Sandstone (Miocene; Weaver, 1949), McLure Shale Member, Modelo Formation (Miocene; Oakeshott, 1958), Monterey Formation (Miocene; Powell, 2001), "Monterey" Formation (Miocene; Adegoke, 1969), Neroly Sandstone (Miocene; Hall, 1960), Santa Margarita Sandstone (Miocene; Arnold, 1906[2]; Vedder, 1973; Addicott and others, 1978; Squires and Fritsche, 1978), upper part of the Temblor Formation (Miocene; Adegoke, 1969), Wimer Formation (Roth, 1979), and unnamed Miocene strata on San Clemente Island (Vedder and Moore, 1976). Addicott (written commun., 1979) *in* Moore (1984) restricts the occurrence of *P. discus* to the "Margaritan" CPMS, but its occurrence in the Castaic Formation, if confirmed, brings that into doubt because the Castaic is at least in part "Jacalitos" CPMS in age (Ensley, 1980; Ensley and Verosub, 1982a, b).

FAMILY TELLINIDAE

Specimens provisionally (aff.) assigned to *Tellina (Peronidia?) aragonia* Dall (1909) differ in a more anteriorly shifted umbo and smaller size. The Arroyo Seco specimens are most similar in outline to *T. castacana* Anderson and Hanna (1925), but lack the slight convex ridge extending from the umbo to the anterior margin and the shell margin anterior of the umbo is concave in our specimens and convex in *T. castacana*. *Tellina castacana* is only known from the Eocene of California and Oregon (Moore, 2003) and its occurrence in the middle to late Miocene with no intervening records is doubtful.

A single specimen referred to *Tellina congesta* (Conrad, 1855) matches well with the type illustrated by Moore (2003). *Tellina congesta* has previously been reported from the Monterey Formation (Miocene; Arnold, 1906; Addicott and others, 1978; Durham, 1966) and Santa Margarita Sandstone (Miocene; Addicott and others, 1978).

Several specimens of an indeterminate Tellinid (figure 11, 13) differ from *Tellina* aff. *T. aragonia* by having a centrally placed umbo and straight to concave outward margins anterior and posterior of the umbo. Fossil Tellinids from the Neogene of California are poorly studied and more work is needed.

FAMILY VENERIDAE

Three incomplete specimens are referred to *Katherinella (Katherinella) angustifrons* (Conrad, 1849) [? syn. *Marcia oregonensis* Dall (1909)] (figures 17) based on shell outline. The specimens from Arroyo Seco appear similar to specimens illustrated in Weaver (1942) and Moore (1963), which show variability in outline and degree of inflation. *Katherinella angustifrons* has previously been reported from the Astoria Formation (Miocene) in southwest Washington and western Oregon (Weaver, 1942; Moore, 1963), the Clallam Formation in northwestern Washington (Miocene; Dall, 1922), the Sobrante Sandstone and Temblor

[2] The Arnold (1906) reference is questioned because Arnold used lithostratigraphic names in a chronostratigraphic sense, but its occurrence in the Santa Margarita Sandstone is supported by other authors.

Formation in central California (middle Miocene; Moore, 1963). It was also reported from the late Miocene to Pliocene Wilson Grove Formation by Travis (1952), but that occurrence was referred to an indeterminate Veneridae by Powell and others (2004). Moore and Addicott (1987) report *K. angustifrons* from the Juanian, Pillarian, and Newportian Oregon/Washington provincial molluscan Stages (late Oligocene to middle Miocene) in the Pacific Northwest.

Nine moderate- to well-preserved specimens of large Venerid (?) bivalves (figures 13-16, 18?) are present but not identifiable. The shells are large (>80 mm), suboval to elongate subtrigonal in outline with broadly rounded anterior, posterior, and ventral margins. The slightly prosogyrate umbo is central, while the area anterior of the umbo is depressed but no lunule is observed. The shells appear to be thin with sculpture consisting of fine, closely spaced, comarginal threads, at least over part of the shell. Overall the shells are similar to *Compsomyax subdiaphana* (Carpenter, 1864) but differ in shell outline and a centrally placed umbo. Unfortunately these features preserved on our specimens do not correspond with any living or fossil eastern Pacific Venerid.

Thirty-one incomplete specimens are assigned to indeterminate Veneridae because the outline of the shell cannot be determined with accuracy and they lack sculpture except for incremental comarginal growth lines.

FAMILY VESICOMYIDAE

Two incomplete, poorly preserved specimens collected as float are questionably assigned to indeterminate Vesicomyidae based on their shell outline (figure 10). It is possible the specimens are not Vesicomyidae but incomplete Veneridae, but an indeterminate Vesicomyid is our best guess based on shell shape. Modern Vesicomyidae are not found shallower than about 500 m in the eastern Pacific (Coan and others, 2000).

MOLLUSCA: GASTROPODA

FAMILY CALYPTRAEIDAE

Twenty-eight moderately- to well-preserved specimens ranging in from 14.7 to 31.7 mm maximum diameter are attributed to an indeterminate *Trochita* (figures 19-21). These specimens are low to moderate in height, wider than high, and show varying degrees radial sculpture, usually along the outer shell margin. Several are, at least in part, internal molds, and surface sculpture is poorly preserved. Numerous fossil *Trochita* are known from California but today the genus is tropical occurring from México south to Chile (Keen, 1971). The specimens here are not well enough preserved to identify to species.

FAMILY NATICIDAE

Four specimens are assigned to indeterminate Naticidae based on their size and shape. They are all crushed and(or) only party exposed so are not identifiable beyond the family level.

FAMILY MURICIDAE

A single specimen appears close in size and shape to *Astrotrophon kernensis* (Anderson, 1905) and is provisionally assigned to that species (cf.). *Astrotrophon kernensis* has been reported from the middle Miocene Astoria Formation in Oregon, and the "Monterey" (Weaver, 1949), Temblor, Topanga Canyon (Vedder *in* Addicott, 1970) formations, and unnamed sandstone of Dibblee (1966), and the late Oligocene to early Miocene Vaqueros Formation (Loel and Corey, 1932; Eaton and others, 1941) in California. Addicott (1970) reported this species from the early to middle Miocene, "Vaqueros/Temblor" CPMS transition zone and "Temblor"

CPMS, while its occurrence here, if properly identified, would extends it range up into the "Margaritan" CPMS.

Other Faual Elements

In addition, to the mollusks, invertebrate fauna elements from several other phyla were encountered. These including 1) the inarticulate brachiopod *Discinisca* cf. *D. lamellose* Broderip (1833[1834]) (figure 26), which is probably the most commonly encountered fossil preserved at this outcrop; 2) an annelid worm in the family Pectinariidae (Finger and others, 2008) (figure 25) which cements foraminiferal test to the outside of its tube; and 3) the pea crabs *Pinnixa galliheri* Rathbun, 1932 (figure 24). Leaves, wood, fish scales, and vertebrate coprolites are also occasionally encountered.

Environmental Interpretation

Modern relatives, at the generic level, to the fossil mollusks collected along Arroyo Seco are commonly found today at inner and outer neritic water depths (0-150 m). With the exception of the family Vesicomyidae, which Coan and others (2000) report living deeper than 500 m off the Pacific Coast of North America. The sediment in which the fossils are preserved is porcelanite, which is made up of the test of tiny animals known as diatoms. Diatoms only accumulate in such vast numbers and not intermixed with clastic sediments in deep water.

According to Patsy Smith (*in* Durham, 1970) the foraminiferal faunas from the underlying Sandholdt Member of the Monterey Formation typify bathyal (200-2000 m) water depths, and mollusks from the overlying Santa Margarita Formation represent inner to outer neritic water depths. Although most of the Arroyo Seco faunule mollusks represent neritic water depths the larger bivalve mollusk are mostly composed of broken single valves indicating transport. Therefore, upper bathyal water depths are not unreasonable when combined with other fauna elements and the sedimentology.

Interpreted water depths likely in excess of 500 m for the upper member of the Monterey Formation and less than 150 m in the overlying Santa Margarita Sandstone indicates an unconformity or nonconformity between the two units to allow time for a shallowing of the water even through these units were deposited during approximately the same period of time ("Margaritan" CPMS, late middle to middle late Miocene).

Age

The pectinid *Pacipecten discus* restricts the age of the Arroyo Seco exposure to the "Margaritan" CPMS (late middle to middle late Miocene; Moore, 1984). The upper member of Monterey Formation is reported to contain foraminifers of the Mohnian benthic foraminiferal stage (Dibblee, 2006; middle middle to middle late Miocene) and is overlain by the "Margaritan" CPMS Santa Margarita Formation (formerly Pancho Rico Formation) close by in Reliz Canyon (Powell, 2007). These data support the "Margaritan" CPMS age for the outcrop discussed here.

Conclusions

Molluscan fossils are rare in the deep-water sediments of the Monterey Formation. The faunule reported here increases the number of molluscan taxa from the upper member of the Monterey near its type locality four fold, from three to 13. Two taxa, both questionably identified, have not previously been reported from biogenetic rocks of the Monterey Formation,

the genus *Calyptraea* and the indeterminate Pandoridae. Most of the taxa reported here are found living at water depths less than 150 m, but microfossils from these rocks indicated they were deposited in deper water (>500 m) indicating significant transport of the fauna. Based on the occurrence of the pectinid *Pacipecten discus* these rocks are referred to the "Margaritan" California provincial molluscan stage and are late middle to middle late Miocene in age.

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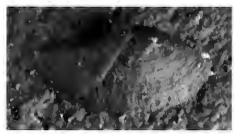
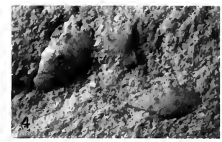
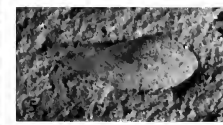
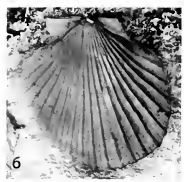
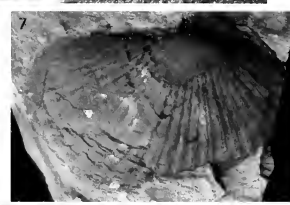
Figures 3-16.—Mollusks and other invertebrate phyla from the upper Member of Monterey Formation along Arroyo Seco, west of Greenfield, Monterey County, California. 3-5. *Nuculana forlongi* (Trask, 1922); 3. Clay cast, exterior, left valve, 4.8 mm high, 9.1 mm wide; 4. Clay cast, exterior, left valve, 4.8 mm high, 9.8 mm wide (upper specimen; incomplete), exterior, right valve, 5.5 mm high, 10.5 mm wide (lower specimen); 5. Exterior, left valve, 4.0 mm high, 9.7 mm width. 6, 8. *Pacipecten discus* (Conrad, 1857); 6, exterior, left valve, 35.8 mm high, 33.4 mm wide; 8. Interior, left valve, 35.8 mm maximum high, 33.5 mm maximum wide (both valves). 7, 10. *Scapharca? obispoana perdisparis* (Wiedey, 1928); 7. Exterior, right valve, 47.5 mm high, 72.9 mm long; 10. Exterior, incomplete right valve, 29.5 mm high, 34.0 mm long. 9. *Tellina* aff. *T. (Peronidia?) aragonia* Dall (1909), exterior, left valve, 10.6 mm high, 19.0 mm long. 11, 13. Tellinidae, indeterminate, 11. exterior, left valve, 9.1 mm high, 15.9 mm long; 13. Articulate pair, maximum height 18.0 mm, maximum width 21.8 mm. 12. Vesicomyidae(?), indeterminate, exterior, left valve, height 48.0 mm, length 70.7 mm. 14. Pandoridae, indeterminate, left valve, 26.2 mm high, 35.2 mm long. 15, 16. Veneridae, indeterminate; 15. Exterior, left(?) valve, 40.8 mm high, 66.2 mm long; 16. Exterior, left valve, 38.1 mm high, 61.5 mm long.

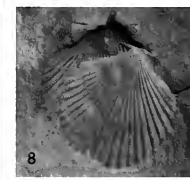


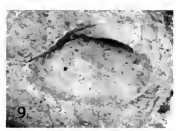


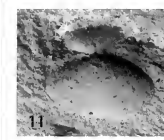


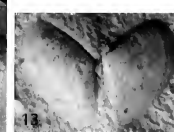


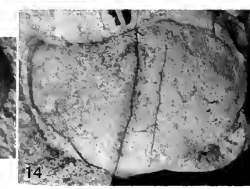


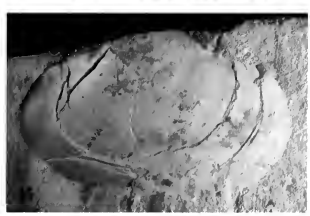












Figures 17-26-.—Mollusks and other invertebrate phyla from the upper Member of Monterey Formation along Arroyo Seco, west of Greenfield, Monterey County, California. 17, 18, 20. Veneridae, indeterminate; 17 . exterior, left valve, 57.2 mm high, 84.1 mm wide; 18. Exterior, right valve, 58.4 mm high, 75.1 mm wide; 20. Exterior, unknown valves, 52.3 mm maximum height, 101.0 mm maximum width. 19. *Katherinella (Katherinella) angustifrons* (Conrad, 1849), left valve, exterior, 64.3 mm high, 77.8 mm length. 21-23. *Trochita* sp.; 21 Aperical view, maximum width 19.4 mm; 22. Aperical view (internal cast), maximum width 19.5 mm; 23. Aperical view, maximum width 22.7 mm. 24. *Pinnixa galliheri* Rathbun (1932), maximum height of upper specimen 14.8 mm, maximum length of upper specimen 27.6 mm. 25. Indeterminate Pectinariidae, maximum height 56.1 mm, maximum width 9.8 mm. 26. *Discinisca* cf. *D. lamellose* Broderip (1833[1834]), maximum diameter of specimen on upper left of slab 20.0 mm.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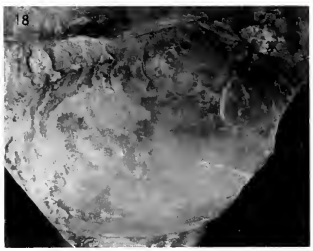
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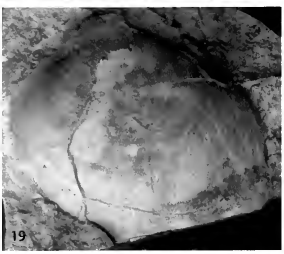
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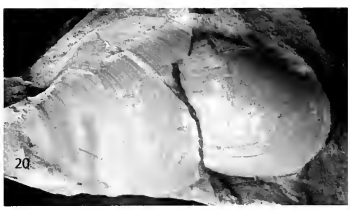
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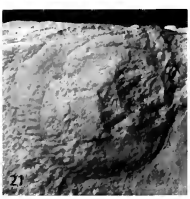
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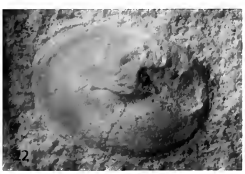
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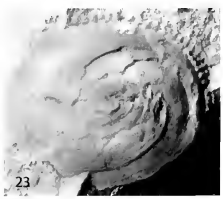
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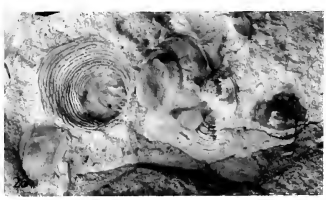
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HOW HIGH THE DIVERSITY?
LAND MOLLUSK DISCOVERIES IN THE PACIFIC NORTHWEST, U.S.A.

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Frest & Roth (1995) discussed land mollusk conservation in the western United States and estimated that for federal forest and range lands in northern California, Idaho, Oregon, and Washington, about 50% of the freshwater and terrestrial mollusk fauna had not been formally described. Over the last 25 years I have examined approximately 3,500 samples of land snails and slugs from predominantly public lands in these states, many of them collected by biologists of the U.S. Bureau of Land Management (BLM) and Forest Service (FS). A sample may represent anywhere from one to several tens of specimens. Proportionally more samples came from the counties of northern California and fewer from Washington and Idaho. The material was mainly from the Cascade, Siskiyou, Klamath, and California North Coast ranges. This is largely mountainous, forested land including old-growth forest.

I have diagnosed species by the traditional, morphological methods of looking at features of the shell and anatomy. The benchmark treatise on North American land mollusks (Pilsbry, 1938-1948; "LMNA") distinguished between species and subspecies. This judgment was usually made on degree of phenetic difference, subjectively judged. It has largely been followed by subsequent authors. For purposes of this analysis I treat all the taxonomic entities I recognize as species, separately evolving metapopulation lineages (de Queiroz, 2005). In practice, much post-Pilsbry work, such that as by Walter Miller and me, has demonstrated LMNA "subspecies" to be species on firm phenetic grounds, such as genital anatomy. From the standpoint of survey and management, federal agencies treat species and subspecies alike in any case.

BLM and FS field workers usually sample according to a standard protocol that involves time-averaged search across all habitats in a given survey area. They are recording many types of organisms, not just mollusks. In contrast, a snail specialist might go into an area and zero in on likely looking spots of microhabitat. He or she might bring litter samples back to the lab to sort. So the diversity I report is likely to be a minimal estimate.

In *Helminthoglypta* (Helminthoglyptidae) LMNA recognized 13 taxa in this region. By 2003, which is the most recent date that a new taxon was described in any of the genera reported on here, two other taxa had been described. New material suggests the presence of four other undescribed taxa.

Vespericola (Polygyridae) has turned out to be a very speciose genus with 11 new species already described by Miller and other authors, and 30 others yet to be published. Many of its species are short-ranging endemics, sometimes occupying one or a few stream drainages and being replaced, one drainage over, by another species of the genus.

In *Trilobopsis* (Polygyridae) 11 species remain to be formally described.

A molecular study of slugs identified as *Prophysaon coeruleum* (Arionidae) by Wilke & Duncan (2004) resolved two well supported (posterior probability >80%) clades and one with 78% posterior probability support among the 40 specimens from 26 localities studied. The only morphological data given by the authors was external body color ("white," "blue," and "dark"). I have examined some material that probably represents their clades "G" and "H" and I think it is

likely that a close phenetic study will show morphological support for three or more such entities.

Additional undescribed species of *Prophysaon* have shown up in material I've examined, leading to the estimate in Figure 1.

In *Monadenia* (Bradybaenidae), an unpublished molecular study by Cordero and Lindberg in 2002 reduced the number of recognizable taxa in the somewhat oversplit *Monadenia fidelis*, but also showed the presence of other unrecognized taxa, for a net gain of two. Another four species have shown up in Pacific Northwest material I have examined. A partial revised taxonomy was published by Roth & Sadeghian (2003, 2006).

Roth (1990) described three new taxa of *Haplotrema* and *Ancotrema* (Haplotrematidae), additional taxa have been recognized in the material under study.

Summing all of the above, there is now evidence for more than twice as many taxa in the families considered (218%) as were recognized at the middle of the last century (Figure 1).
This does not include the many other categories of land mollusks that are less reliably captured or detected by the FS and BLM search protocols, such as Vertiginidae, Punctidae, and the zonitoid families such as Gastrodontidae. Recent papers have described three new genera and species of slugs (Leonard et al., 2003; 2011). The genus *Oreohelix* (Oreohelicidae) is being reappraised by Kat Weaver using a combination of molecular and morphologic methods.

It appears, therefore, that at least for terrestrial mollusks the Frest & Roth (1995) estimate of undescribed diversity understated the case. The work of formally describing new species in the peer-reviewed literature is in progress.

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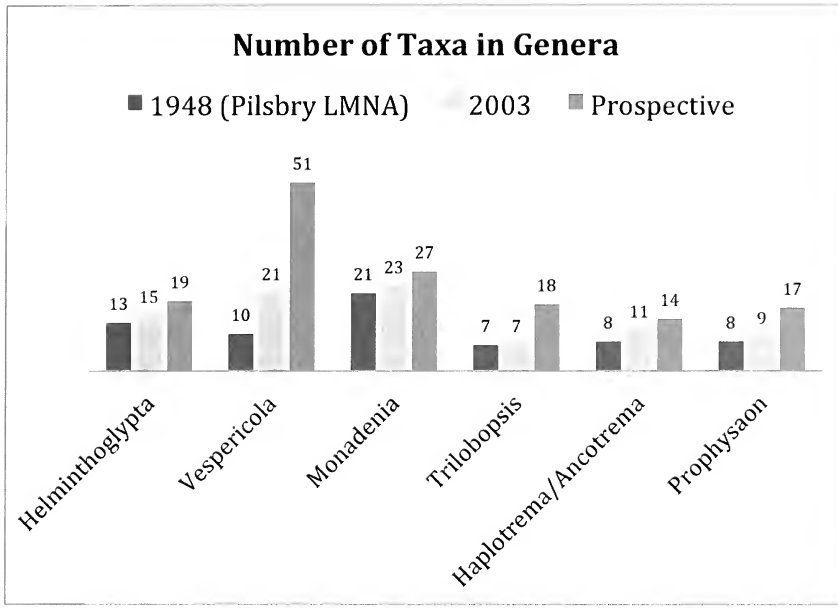

Figure 1. Comparison of number of formally described taxa (as of 1948 and 2003) and prospective number when recognized new taxa are described.

AGE DETERMINATION AND GROWTH OF *CHIONE CALIFORNIENSIS* (BRODERIP, 1835) (BIVALVIA: VENERIDAE) IN THE BAHIA DE LA PAZ, GULF OF CALIFORNIA, MÉXICO/ EDAD Y CRECIMIENTO DE *CHIONE CALIFORNIENSIS* (BRODERIP, 1835) (BIVALVIA: VENERIDAE) EN LA BAHIA DE LA PAZ, GOFO DE CALIFORNIA, MÉXICO

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Abstract

In Bahía de La Paz we performed a study on the growth of the clam *Chione californiensis* using growth bands analysis on the shells. For the analysis of size as a function of age we used the Von Bertalanffy growth model. To validate the seasonality of the growth bands we captured and measured 60 individuals who presented an average size of 15.38 ± 1.08 mm. These individuals were marked and returned to their habitat at a depth of 6 m. They were recaptured monthly over 22 months to determinate changes in their size and numbers of growth bands. In addition, we recorded *in situ* temperatures. Over the 22 month period we recaptured the 60 individuals 217 times. These marked clams had an average monthly growth of 0.40 mm over the 22 months of the experiment. By counting growth bands we determined six age groups. The growth equation parameters were: $L\infty$ = 41.97 mm; k= 0.64 and t0 = -0.02. From the height-weight relation we determined an alometric growth of $y = 0.006 x2.87$. Clam shells with a height < 30 mm tended to increase their height over their weight, while > 40 mm show a tendency to slow their growth and increase their weight.

En la Bahía de La Paz (24°07'-24°21'N, 110°17'-110°40'W) se estudia el crecimiento de la almeja Chione californiensis aplicando el método de análisis de las bandas de crecimiento en las conchas. Para el análisis de la talla en función de la edad, se utilizó el modelo de crecimiento de Von Bertalanffy. Para validar la estacionalidad de las bandas se capturaron, midieron y marcaron 60 individuos con una talla promedio de 15.38 ± 1.08 mm, que se regresaron a su hábitat, a una profundidad de 6 m y posteriormente se recapturaron para determinar mensualmente, durante 22 meses, cambios en talla y número de bandas de crecimiento; se recolectó información sobre temperatura in situ y la concentración de Clorofila a. Para el análisis del crecimiento mediante el uso de las bandas de crecimiento se utilizaron 217 ejemplares recolectados en la Bahía de La Paz. Las almejas marcadas tuvieron un crecimiento promedio mensual de 0.40 mm durante los 22 meses del experimento y se identificó una alternancia de bandas de crecimiento, observándose la presencia tanto de bandas obscuras como de bandas hialinas, caracterizándose la primera por ser más ancha y formándose en verano mientras que las hialinas en invierno. Mediante el recuento de las bandas de crecimiento se detectaron seis grupos de edad, los parámetros de la ecuación de crecimiento fueron: L_∞ = *41.97 mm; k= 0.64 y* t_0 = *-0.02. De la relación altura-peso mostró un crecimiento del tipo alométrico con valores de* $y = 0.006^{x2.87}$, *las conchas de las almejas con altura menor a 30 mm tienen una tendencia a aumentar más su altura que su peso, mientras que después de los 40 mm muestran una tendencia a disminuir su crecimiento y aumentar su peso*

Key words: Mollusks, Gulf of California, growth bands, benthos

Introduction

Mollusk shells form extensive accumulations that contribute greatly to the formation of carbonate sediments of biogenic origin (Flessa & Ekdale, 1987; Flessa et al., 1993). The most important factor that contributes to the carbonate formation of biogenic origin is the rate of shell and skeleton deposition from the marine invertebrates community. The study of shell/animal growth determines the corporal size (weight gain in the soft parts and of the shell) as a function of the age. The length or height of an organism is a measure used to group a population into age classes. However, we need the relationship between size and age (Sparre & Venema, 1995) to evaluation if this works with size composition data (Gulland, 1971; Sparre & Venema, 1995).

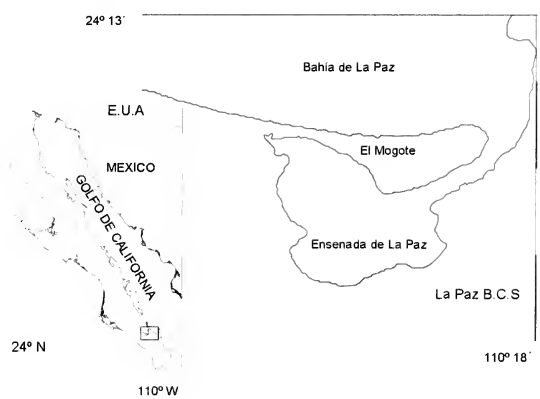
Objective

To determinate the age and growth of the clam *Chione californiensis* in Bahía de La Paz using growth bands.

Study area

Bahía de La Paz is situtiated on the southeast coast of the Baja California Peninsula (24.1° to 24.8° N and 110. 2° to 110.8° W). On the south side of the bay is an embayment called Ensenada de La Paz (La Paz Cove), which is a shallow water habitat protected from waves by a sandy bar called El Mogote (Fig. 1). Our work was done within Ensenada de La Paz.

Figure 1. Geographic position of the study area



Growth marks validation

For the size analysis as a function of the age we used the Von Bertalanffy growth model. The determination of growth equations using weight and length are reduced to the calculation: $L\infty$, K y t0. For their estimation we used the method of Ford-Walford (1957) cited by Sparre & Venema (1995) that uses the regression on shell height of an age class (Lt) against the height at the next age class (Lt+1).

To validate the seasonality of the growth bands we analyzed the growth by using the capture-marked-recaptured method. We captured 60 individuals that were measured and then marked with a diamond-tipped pen; these individual had an average size of 15.38 ± 1.08 mm. As many as possible were recaptured each month over a 22 month period to measure changes in size and the numbers of growth bands. We also collected *in situ* temperatures. Over the 22 months 217 recollections of the original 60 animals were accomplished.

Results

The 60 clams had an average monthly growth of 0.40 mm over the 22 months of the experiment. The wider, dark bands were formed in the summer while the hyaline bands were formed during the winter (fig. 2 and 3).

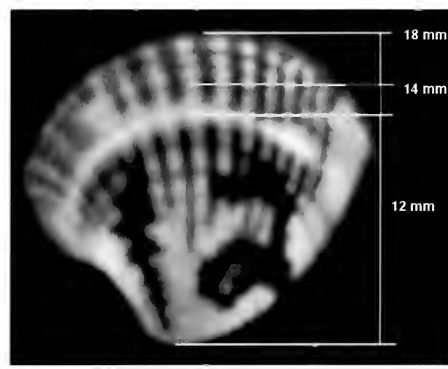


Figure 2. The clam *Chione californiensis* showing the first hyaline band at 12 mm and an increment of 4 mm in 5 months.

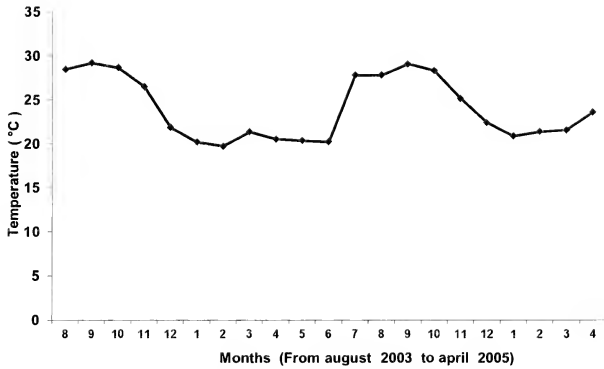


Figure 3. Darks bands were formed in the summer while the hyaline bands were formed during the winter.

The equation parameters determined are: $L\infty = 41.97$ mm; k= 0.64 and t0 = -0.02 (Fig. 3). Thus the relationship between height and weight shows allometric growth with a value of y = 0.006 x2.87. *Chione* shells with a height < 30 mm have a tendency to increase their height over their weight, while shells > 40 mm tend to increase their weight over height.

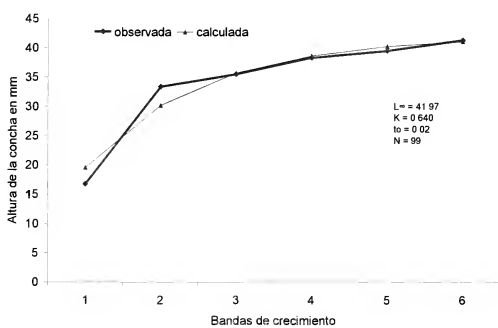


Figure 3. Curves and parameters of growth of the equation of Von Bertalanffy for *Chione californiensis*.

Conclusions

During the 22 months we monitored the growth of *C. californiensis* in Ensenada de La Paz we recorded a monthly growth rate of 0.40 mm. Schöne et al., (2003) report for *C. cortezi* an incremental growth rate in the upper Gulf of California of 0.4 cm per year while for *C. fructifraga* from the same area a growth rate of 0.25 cm/month was determined. The former mates well with that determined for *C. californiensis* here (0.48 cm per year), while the latter is significantly less.

We estimate that a cohort of *C. californiensis* (group of individuals born in the same area at a same time) at its maximum height ($L \infty = 41.97$) produce 5 g of CaCO3 per year.

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SOCIETY BUSINESS

SECRETARY'S REPORT

Minutes of the Executive Board Meeting - June 25, 2012
Univeristy of California, Santa Cruz, CA

- Meeting called to order at 5:22 PM by President Janet Leonard.
- Current WSM officers present include: Kelvin Barwick, Wendy Enright, Janet Leonard, Charles Powell, II, and Paul Valentich-Scott. Former WSM Presidents present include: Hans Bertsch, Carlos Cáceres Martínez, Esteban Félix Pico, Nora Foster, Angel Valdes
- Secretary's report – minutes from 2011 La Paz board and general meeting were taken and read by Hans Bertsch. Motion to accept by Paul Valentich-Scott, second by Wendy Enright, passed unanimously.
- Tresurer's report – Kelvin Barwick presented report on financial standing of the Society and the hopeful resolution of our lapsed 501 3c status. Motion to accept by Paul Valentich-Scott, second by Hans Bertsch, passed unanimously.
    - We have reapplied for 501 3c status with the IRS. Forms accepted by IRS as of 6/15/2012 for review within the next 90 days.
  - Motion to commend Kelvin Barwick for his resolution of the IRS problem. By Janet Leonard, second by Paul Valentich-Scott, passed unanimously.
- Janet Leonard made a motion to update the Society's by-laws and officers position description. Second Hans Bertsch, passed unanimously. Janet consitituted a committee headed by Wendy Enright and including Kelvin Barwick and Hans Bertsch to make a draft to be presented at the next meeting.
- Proposed slate of officers for 20012-2013
    - President – Wendy Enright
    - 1st Vice-President – Paul Valentich-Scott
    - 2nd Vice-President – open
    - Treasurer – Kelvin Barwick
    - Secretary – Charles Powell, II
    - Members-at-Large appointed by President Janet Leonard – Ángel Valdés, George Kennedy
    - Editoral board appointed by President Janet Leonard – Hans Bertsch, Rosa Campay, Nora Foster, Janet Leonard, and Charles Powell
  - Motion to accept slate of officers by Hans Bertsch, second by Paul Valentich-Scott, passed unanimously.
- Wendy Enright previewed the 2013 WSM meeting to be held in San Diego, CA, July 28-31, 2013. The exact venue is not set.
- Paul Valentich-Scott previewed the 2014 WSM meeting to be held jointly with the American Malacological Society, and the Latin American Malacological Society in México City, México. The exact venue is not set. 300-400 people are expected to attend.
- Motion to adjourn by Hans Bertsch, second by Wendy Enright, passed unanimously 6:15 PM.

Respectfully submitted by Charles Powell, II, Secretary

Minutes of the General Membership Meeting – June 26, 2012
University of California Santa Cruz, CA

- WSM President Janet Leonard called the meeting to order at 4:31 PM, 24 members present.
- No student grants will be awarded this year.
- Janet Leonard let the membership know that we will be updating the Society's by-laws and officers position description. The committee to rewrite them is lead by Wendy Enright and includes Kelvin Barwick and Hans Bertsch.
- Proposed slate of officers for 20012-2013
    - President – Wendy Enright
    - 1st Vice-President – Paul Valentich-Scott
    - 2nd Vice-President – open
    - Treasurer – Kelvin Barwick
    - Secretary – Charles Powell, II
    - Members-at-Large appointed by President Janet Leonard – Ángél Valdes, George Kennedy
    - Editoral board appointed by President Janet Leonard – Hans Bertsch, Rosa Campay, Nora Foster, Janet Leonard, and Charles Powell
  - An amendment was made to allow for Charles Powell to serve a year past his term limit and to continue as secretary for the coming year. Motion by Doug Eernisse, second by Paul Valentich-Scott, passed.
  - Motion to accept slate of officers by Janet Leonard, second by Kelvin Barwick, passed.
- Treasurer's report – Kelvin Barwick gave brief run down on the financial health of the WSM. Motion to accept by Paul Valentich-Scott, second by Doug Eernisse, passed.
  - Membership Report. Membership down to for 2012 to 40 individuals and 7 Institutions.
  - IRS update. Our 501 3c states has lapsed and is in the process of being reinstated.
- Members-at-large Report – Hans Bertsch reports that the annual report from the La Paz meeting is in the works and will hopefully be reviewed by November.
- Wendy Enright previewed the 2013 WSM meeting to be held in San Diego, CA, July 28-31, 2013. The exact venue is not set.
- Bivalve symposium by Paul Valentich-Scott, possible Paleo and Digital micro photography workshop
- Paul Valentich-Scott previewed the 2014 WSM meeting to be held jointly with the American Malacological Society, and the Latin American Malacological Society in México City, México. Tentatively scheduled for June 23-28, 2014. The exact venue is not set. 300-400 people are expected to attend.
- New Business
  - Chris Gallina a student of Doug Eernisse's will take over the WSM blog, which is lcoated at http://westernmalacologists.blogspot.com/. Doug will continue to run our Facebook page.
  - Hans Bertsch made a motion to commend Jan Leonard for her hard work. Second by Kelvin Barwick, passed.

- Motion to adjorn by Hans Bertsch, second by Doug Eernisse, passed unanimously. Meeting adjourned 5:07 PM.

Respectfully submitted by Charles Powell, II, Secretary
31 July 2012

TREASURER'S REPORT

May 3, 2014

Members,

Below are the cash flows and balances for 2012.

Kelvin Barwick
Treasurer

Inflows		
Individual Member Dues	$1,140.00	
Institutional Member Dues	$200.00	
Interest Earned	$6.58	Banks Savings Account
Merchandise	$25.00	T-shirt purchase
Student Grant	$5,494.90	Donations
Total inflow	**$6,866.48**	
Outflows		
2012 Conference	$2,348.16	
Bank Charges	$12.00	
CA Nonprofit registry	$20.00	
Office supplies	$40.21	
Postage	$45.00	
Report Production	$227.48	
Fee	$500.00	To IRS for 501(3)(c) application
Total outflow	**$3,192.85**	
	Net	**$3,673.63**

Cash on hand December 31, 2012

Checking	Savings	**Total**
$14,637.44	$13,126.88	**$27,764.32**

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